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THE NEW MAUSOLEUM.

THIS new method, which we will now proceed to illustrate and describe, is under the charge of the New Mausoleum Company, of which Mr. James S. MacCoy is the president and Charles A. Harvey, D.D., secretary, its principal office being in the Madison Square Bank building, Fifth Avenue and Twenty-fifth Street, New York.

An important enterprise has lately been inaugurated in New York, which has for its object the disposal of the dead in a manner so superior to the prevailing method as to commend itself strongly to popular favor. The projectors of this improved system of sepulture, after years of careful study, assisted by the most experienced architects, have perfected their plans and reduced them to practical form. Before long they will commence the erection of a series of noble structures that, while adorning the localities where they are placed, will be cherished as the sacred resting places of the beloved dead.

There is in all countries, among all classes, a feeling of repulsion concerning earth burial. The deep grave in which the remains of loved ones are to be hidden forever; the clods of earth thrown upon the sacred casket by the coarse hand of the gravedigger; the reluctant leave-taking, when the dead seem to be left in so unfit a resting place; the certainty that the grave will be, partially at least, filled with water during every wet season, and in some soils perpetually; the uncertainty that those loved remains will repose in peace even there, and not be exhumed by some ghoul to find their way to the dissecting table; and, worse than all, the awful suspicion that life may not have been extinct, and that possibly they have been buried alive, and may come to consciousness to experience the most horrible emotions the imagination can picture—these are some of the considerations that render the practice of burial revolting.

But the objections to earth burial are by no means confined to those that pertain to a tender feeling and a refined sentiment. The sanitary aspect of earth burial discloses undeniable danger to the living. Indeed, the necessity of protection against the dead, when interred, has in the past few years been anxiously discussed by clergymen, hygienists, sanitarians, and members of the leading medical associations.

The prohibition of intra-mural interment in London was preceded by an investigation on the part of the General Board of Health, and the searching inquiry led to this conclusion:

"We may safely rest the sanitary part of the case on the single fact that the placing of the dead body in a grave and covering it with a few feet of earth does not prevent the gases generated by decomposition, together with putrescent matters which they hold in suspension, from permeating the surrounding soil and escaping into the air above and the water beneath."

A report of the French Academy of Medicine states that, even under modern conditions, the putrid emanations of Pere-la-Chaise, Montmartre, and Montparnasse—once suburban but now intra-mural—have caused headaches and loss of vigor and frightful diseases of the throat and lungs; and that many fall victims every year to the diseases of which these cemeteries are the source.

A comprehensive inquiry in 1875 induced the Massachusetts Board of Health to present this aphorism:

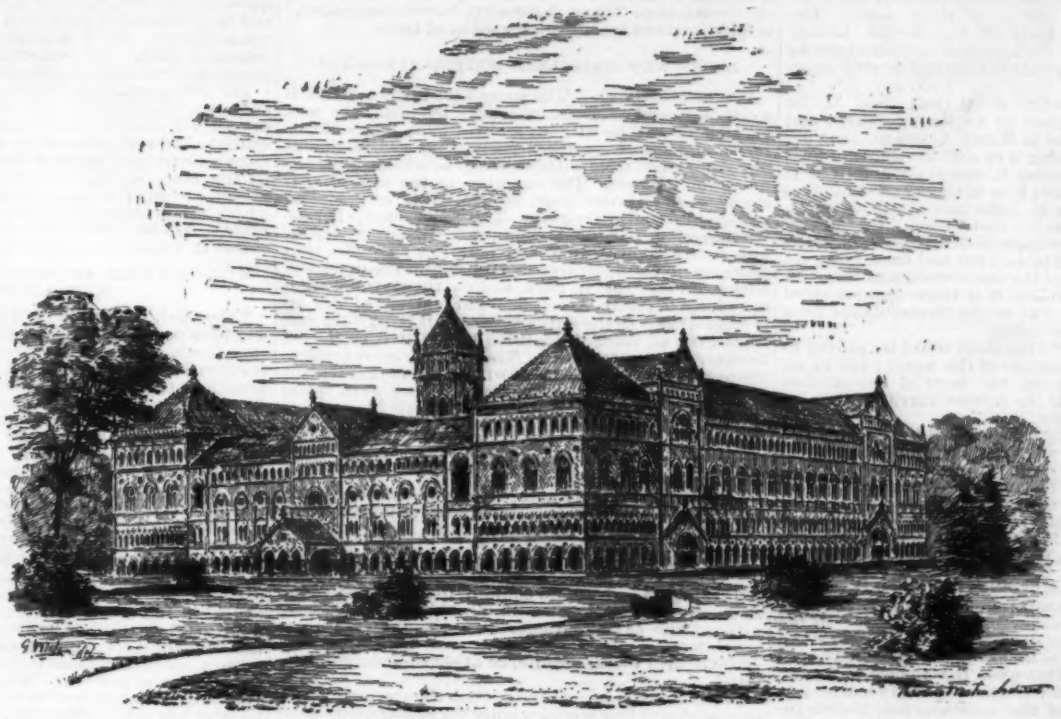
"Burial in contracted spaces of ground in the midst of cities and villages, as practiced by all Christian nations from very early times until a period comparatively recent, and not yet wholly discontinued, has been repeatedly proved to be injurious to the health of a community, in proportion as such spaces of ground are overcrowded with bodies. This malign influence is most apparent during epidemics, when the mortality in the vicinity of these burial grounds has been frequently observed to be excessive."

In 1886 a committee, headed by Dr. James M. Keller, made a report to a section of the American Medical Association, then in session at St. Louis, from which we quote:

"We believe that the horrid practice of earth burial does more to propagate the germs of disease and death, and to spread desolation and pestilence over the human race, than do all man's ingenuity and ignorance in every other custom or habit. . . . The fatal delusion, that the earth renders harmless and innocuous the corpse must be dispelled. Incontrovertible proof of the fact that the vicinity of graveyards is unhealthy is superabundant. That the dead do kill the living is equally true, and that cholera, yellow fever, and the whole list of zymotic and infectious diseases are propagated by contaminating the earth, air, and water supplies, is as true as that sewer gas or sewage water do propagate disease. Point to a city, if you can, whose growth has demanded the removal of the dead from its cemetery, that will not attest the truth of the rapid production of disease and death in all neighboring localities. 'God's acre' must become a thing of the past. The graveyard must be abandoned. The time has come for us to face squarely the problem how to dispose of our dead with safety to the living. And your committee has an abiding faith that you will earnestly and at once say that the earth was made for the living, not for the dead, and that pure air, pure water, and pure soil are absolutely necessary for perfect health. Only skeptics deny that the dead do poison these three essentials of human life."

The disposal of the dead by desiccation is the mission of the New Mausoleum Company, and it seems strange in an age of progress in the refinements of civilization as well as in more material things, that desiccation has not sooner become an acceptable and practicable method.

Desiccation is the art of preventing putrefaction and all its revolting changes, by forcing over and around the body a continuous current of dry air. It is the process that nature applies in the desert, when an unfortunate traveler, or his camel, succumbs to the tortures of thirst; the process that preserves from decay articles of food that other processes cannot preserve; the process that, by sanitation, annually saves, in crowded schoolhouses, many valuable lives; it is nature's own method—the agency of evaporation—and this, applied to the lifeless body, saves it from the loathsome transformations that



THE NEW MAUSOLEUM, OR CAMPO SANTO, FOR NEW YORK.

PRINCIPAL CORRIDOR OF THE NEW MAUSOLEUM IN VENETIAN RENAISSANCE STYLE.

are inseparable from subterraneous dissolution. "We think," says Southey, "of the grave, corruption, and worms." Desiccation promises to drive from the mind this established association of ideas.

The corrupting mass, "for which," as Bossuet says, "there has been found no name in any human language," will disappear from our literature, and the last tribute to mortality will lose its repellent features. From the unspeakable chemistry of earth burial and the unacceptable action of the furnace, desiccation may be said to have come as a welcome deliverance.

The scientific value of desiccation is not disputed. Dr. William H. Welch, Professor of Pathology in Johns Hopkins University, Baltimore, declared in an address before the American Medical Association, on June 26, 1889, that the vitality of pathogenic bacteria "is rapidly destroyed by complete desiccation." Dr. G. M. Sternberg, general director of the Hoagland Laboratory, in a lecture published in the *Brooklyn Medical Journal* for June, 1889, says: "The cholera spirillum is destroyed in a few hours by desiccation. The typhoid bacillus takes a longer time; but exposure in a dry condition to oxygen is one of the most effective ways of destroying this and other pathogenic organisms. These microbes appear to flourish in moist places, while many of them are absolutely unable to retain their vitality in a dry atmosphere."

Yet the theory is not novel. The Colchians and Tartars practiced desiccation by suspending their dead upon trees for the space of three years, to be dried by the air and the sun. Herodotus tells us that the Ethiopians desiccated the bodies of their dead. The manner in which the body of the heroic Livingstone was prepared for its long and arduous journey seems to show that the primitive custom is still practiced in Africa.

The ancient Peruvians first dried their dead in the sun, and then buried them in a sitting posture; and travelers tell us of a tribe in South Australia that desiccate the body by placing it in a sitting posture near the top of the hut, keeping it there until it is dry, when they bandage it, and hide it among the branches of trees. The Looshais in India and the Aino aborigines in Japan also practice desiccation. In the well known catacombs of the Capuchin monks near Palermo, the bodies are dried in an oven and then hung up in niches, and, in spite of the eccentricities of this famous repository of dead friars, it is there demonstrated that a desiccated body will retain its semblance for a time that is almost measureless.

No doubt desiccation of the dead could be proved to be one of the historic customs of the world; but as all previous practice of the art has been of the crudest kind, it is not important to devote further space to this branch of the subject.

For crude methods it is now proposed to substitute a method that is both scientific and skillful, that will utilize to the fullest extent the preservative power of the atmosphere, when the moisture has been taken from it, which will then convey away in dry-air currents the gases and the fluids which constitute more than three-fourths of the bulk of the human body. This is to be accomplished in a "new mausoleum."

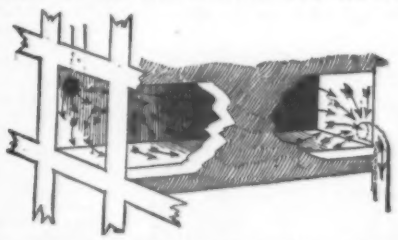
IS THE NEW METHOD PRACTICAL?

Experience is the true test; and, accordingly, neither effort, nor time, nor money have been spared in the endeavor to thoroughly demonstrate the efficacy of a dry air current upon the tissues of a lifeless body.

The effect of desiccation upon the tissues was ascertained: interstices were left where the fatty matter had been, and the drying of the muscular and fibrous tissues had changed the interior of the subject to a cellular and sponge-like structure.

The result of this test deeply impressed a considerable number of physicians and specialists, and arrangements were at once made, through a coroner of one of our large cities, for the application of the process to a human body. The results were again satisfactory in every respect, and these gentlemen were amazed that a process so important to science and to human welfare, yet so simple and effective, had been so long withheld from knowledge and use.

It was now determined to continue the series of ex-



periments, under the supervision of the most eminent experts, in a prominent laboratory in the city of New York. A temporary sepulcher with mausoleum apparatus was erected in the laboratory, and the body of a man, that weighed one hundred and sixty-four pounds, was placed therein and subjected to this process, in June, 1888. After eight months of continuous treatment, the skin remains without discoloration, and as white as at first, although it is dry and hard, and feels like leather; and the face, the least emaciated of any part, is almost life-like, and would be readily recognizable. The facilities were then enlarged, and other equally satisfactory demonstrations have been made.

The practicability of the process was fully demonstrated in each of the cases. The desiccated bodies, with the simple apparatus employed in the experiments, can be seen by any one desirous of investigating the matter. Permission to visit the laboratory can be obtained by applying at the office of the New Mausoleum Company. The tests in the laboratory were witnessed from beginning to end by experts, who watched their development from a scientific standpoint.

Nothing better can be added, in proof of the practicability of the system, than the simple announcement of the official connection, in the inauguration of the new mausoleum, of Professor Charles Inslee Pardee, M.D., Dean of the Medical College of the University of the City of New York, and of Dr. Rudolph A. Witthaus, Professor of Chemistry and Physics in the same college, as a result of their personal conviction from close and careful observation.

It is, then, absolutely demonstrated, in completed tests, that a current of dry air will preserve a body from all taint or traces of decomposition, and, in the end, transform it into a condition in which it will remain an indefinite length of time, wholly inoffensive to either sight or smell. These tests are confirmed by the results of Mr. Smead's remarkable sanitary system and by a long line of crude methods of desiccation applied to the human body in other parts of the world. The statement is therefore made, without qualification or fear of successful contradiction, that desiccation is a perfectly practicable process, and that it has been subjected to the most thorough examination by some of the keenest and most capable scientists in the country.

It should not be forgotten that the history of all desiccated bodies shows that, once desiccated, they remain so for a length of time that no one can name. They do not gather moisture. The tests before mentioned furnish evidence that in our climate, moisture is not regained in sufficient quantity to reinaugurate decomposition. Nothing approaching it takes place. Many desiccated bodies, from Mexico and Peru, have been brought to this country, some of which can be seen in the anthropological department of the Smithsonian Institution, Washington, and the climate has no more effect on them than it has on an equal quantity of leather or wood. "The remarkable power of drying," says Dr. Bayles, in a paper read before the Public Health Association of New York, "is forced upon our attention by many observations and experiences;" and the declaration, "Once desiccated, forever desiccated," is fully justified by a long succession of facts.

IS THE NEW MAUSOLEUM METHOD SANITARY?

It is eminently so. The space that holds a casket is a cell of concrete. Built up, inch by inch, the new mausoleum will be without seam or joint, a monolithic house of concrete, neither permitting the escape of liquids or gases from within nor the admission of moisture from without. The entrance to the sepulcher is closed with an outer door, bronze, silver, or gold, and an inner door of plate glass. This inner door is hermetically sealed. Through conduits, a current of dry air quickly stays corruption, and performs the office that exposure in the open air accomplishes in the deserts of Africa, on the coast of Peru, and on the elevated western plains of North America. This current of dry air is then drawn to the furnace, where it is purified and freed from all hurtful qualities, before it is permitted to enter the atmosphere. There is no corruption in the sepulcher; there is no unwholesome or unpleasant odor in any portion of the building, not even where the air issues from the furnace; and ample ventilation and warmth, within the elegant and splendid structure, take from it the feeling of dread and the sensation of dampness which those who enter other tombs commonly experience.

Exceedingly weighty and perfectly satisfactory testimony is given as to this feature of the new mausoleum method.

WILL THE STRUCTURE BE INDESTRUCTIBLE?

That a mausoleum, to contain thousands of sepulchers, can be constructed of durable materials goes without the saying. Concrete is the preferable material, faced, perhaps, for purposes of ornamentation, with vitrified brick, granite, or other time-defying material.

It should not be assumed that the strength of the proposed building would wholly depend upon its outer walls. From the foundation, the concrete walls of the thousands of sepulchers and of the arched halls and corridors would go up with the outer walls, the whole forming one immense casting without seam or joint—a monolithic structure. The foundation of such a building may be said to be its entire length and breadth. How can such a building be thrown down? An earthquake that would materially injure it would not elsewhere leave one stone upon another. Whether constructed wholly above ground, or in part below the surface, such a structure would outlast any contemporaneous edifice; for history discloses the fact that "the house of concrete, after centuries of resistance to the elements, war, and earthquake, could only be destroyed by dynamite."

The value of concrete is well and widely known, and in the days of the Babylonians, Egyptians, and Phœnicians, as well as of the Greeks and Romans, no building material was more highly esteemed. The uses of concrete are various. It is chiefly remarkable for the hardness, insolubility, and practical impenetrability it attains.

It is invaluable in the construction of breakwaters and moles; and, whenever buildings are erected upon loose or damp subsoils, it not only forms a solid foundation slab, but resists the capillary ascent of moisture, which would force its way through brickwork or stone. A portion of Pimlico, in the fashionable quarter of London, was formerly a pestiferous marsh, and would to-day be of little value, were it not for the impervious concrete beneath it; and this artificial stone has given not only stability to the buildings, but also health to their occupants by shutting out the exhalations of the soil.

In the forest of Fontainebleau, there are three miles of arches, some of which are fifty feet high, that are a part of an ancient aqueduct for supplying water to Paris; the entire aqueduct was constructed of concrete, and formed a single structure, without joint or seam. A Gothic church, at Vezinet, near Paris, that has a spire 130 feet high, is a monolith of concrete. The lighthouse at Port Said, the northern terminus of the Suez canal, is a monolith of concrete 180 feet high, and the jetties which form the harbor of Port Said were built of great blocks of concrete. Similar use has been made of it at Marseilles, in the harbor of Algiers, in the London docks, at the Dover breakwater, and in the sea forts of Copenhagen.

In the erection of the new mausoleum, the concrete will be prepared on the spot, poured into place while soft, rammed solid, three inches at a time, over its whole extent, including the multitude of inner walls—care being taken to secure perfect crystallization, and such a strong cohesion of the material as to render the entire structure more than rock-like in its solidity. When a roof of stone (or glass, several inches thick, which is made expressly for such purposes) is placed upon this monolithic mausoleum, the world will have a monument as nearly indestructible as man can make it.

WILL THE NEW MAUSOLEUM PREVENT PREMATURE ENTOMBMENT?

When we consider how few safeguards attend the disposal of the dead in this country, it is not strange that accounts of premature interments frequently appear in print, and that some of them are of the most harrowing nature, related with a minuteness of circumstance that brings them at least within the realm of probability. It is not our purpose to reproduce these distressing tales. The possibility of burial alive is appreciated by every one. There is a dread of it that cannot be shaken off, and perhaps no class of men dread it more than the members of the medical profession.

That burial alive is a danger to be guarded against is shown in the establishment of buildings for temporary entombment, in many cities of Germany and England. At Frankfort, this is at the entrance to the cemetery. It consists of a warder's office, where an attendant is always on duty, and, on each side, five small rooms, well ventilated, kept at an even temperature, furnished with biers, on which bodies brought for burial are laid. A ring is placed on one of the fingers of such a body, to which is attached a light cord, which connects with a bell at the attendant's door. The bodies thus arranged are also inspected at regular intervals by a medical officer. The attendants are required to receive and treat the dead with all respect, and no interment is permitted until signs of decomposition appear. The relatives are then notified, and the funeral is held. The importance of this care was once proved at Frankfort by the revival of a child.

The new mausoleum offers perfect protection against entombment of the living. The constant current of dry air will tend to resuscitate, the glass door permits continual inspection, and an electrical apparatus, far more sensitive and efficient than a bell cord, is adjusted to the body, so that the slightest movement in the casket, either of limb or muscle, will start an alarm, which will continue for hours, if need be, and an indicator will direct the attention of the custodian to the casket in which the movement has occurred.

WILL THE DEAD BE SECURE FROM THEFT IN THE NEW MAUSOLEUM?

They certainly will. With the entrance and the windows protected by the best and strongest defenses that mechanical skill can devise; with custodians constantly on duty, maintained from the fund for perpetual care, there is no reason why bereaved friends should have a moment's anxiety for the security of those who rest in the new mausoleum. The contents of a bank vault are not safer from robbery. This is a safe depository for the dead.

The extent of grave robbery is not easily defined. The ghastly practice is secretly approved by many reputable people, in the so-called interest of science and humanity. In the eye of the law it is only a misdemeanor, and, under the English law, it is scarcely punishable at all. Therefore, to the friends of the dead, this is a constant source of anxiety, trouble, and expense. A few years since, great excitement was caused in Indiana by thefts from graves, and a prominent gentleman, no other now than the president of the United States, was persuaded by his neighbors to go to a medical college in Cincinnati and search for the remains of a friend. While he was inspecting the vats where "cadavers" were kept, to his horror the body of his own father, who had died about a month before, was presented to his view. This shocking incident will be remembered by many who knew of it at the time. The body of President Lincoln barely escaped the clutches of thieves, who were actually caught in an attempt to steal it for the heavy ransom they could exact, and it was not until 1887 that it was taken from its secret resting place and placed in the vault of the Lincoln monument, in Oak Ridge Cemetery, Springfield, Ill. "The history of vaults, graveyards, and cemeteries," says Mr. Haweis, in "Ashes to Ashes," "is one long history of desecration and outrage."

Many devices have been adopted to secure the dead from theft, but these devices are so expensive that few can resort to them, and even then they do not always insure security. The new mausoleum, however, offers protection to the form that rests in its least expensive sepulcher, far better than that afforded in the costly granite pile to the dust of the dead millionaire.

SUMMARY.

The advantages of this new system may be summarized as follows:

1. It is eminently sanitary. The lifeless body, in a sepulchral space of solid stone, is subjected to rapid dry air currents, which convey to the distant furnace, and there make innocuous, the aerified fluids and gases, with such germs of disease as there may be, and leave behind the desiccated solid matter, hermetically sealed from contact with the atmosphere, in contact only with dry air, in which no disease germ can develop.
2. It quickly restores to the atmosphere the elements which are needed by vegetation for its own subsistence. These elements constitute three-fourths of the bulk of the body.
3. It prevents putrescence; it is incompatible with putridity.
4. It preserves the form, and particularly the features, of the beloved dead for an indefinite period of time.
5. It takes from the last ceremonies all revolting features.
6. It enables friends to participate in the funeral rites without detriment to their own health.
7. It makes it impossible to steal the dead.
8. It provides constant evidence that premature entombment has not occurred.
9. It provides a home for the dead, in which are secured to them as perfect repose and protection as they could enjoy in life.
10. It is a disposition of the dead in accordance with nature's own laws, and in consonance with the natural moral law, which constrains every heart to care tenderly for the remains of the loved and departed.
11. It costs less, especially in consideration of the many valuable advantages which are secured.

12. It does not poison the air we breathe or the soil we inhabit and subsist upon.
13. It does not change the rains of heaven into purveyors of deadly germs.
14. It does not disturb in the slightest degree the traditions of religion.
15. It does not destroy evidence of secret homicidal crime.
16. It does not annihilate in a whirl of white heat the form dearly loved.

knowing that there they are forever secure from harm. The anxiety of friends to follow the remains of loved ones to their final resting place, and to show them the utmost honor, often impels them in delicate health to stand with uncovered heads at the open grave, when the earth is cold and wet, and even in driving storms, and there are few who cannot call to mind some friend whose death has not been the direct result of such exposure.

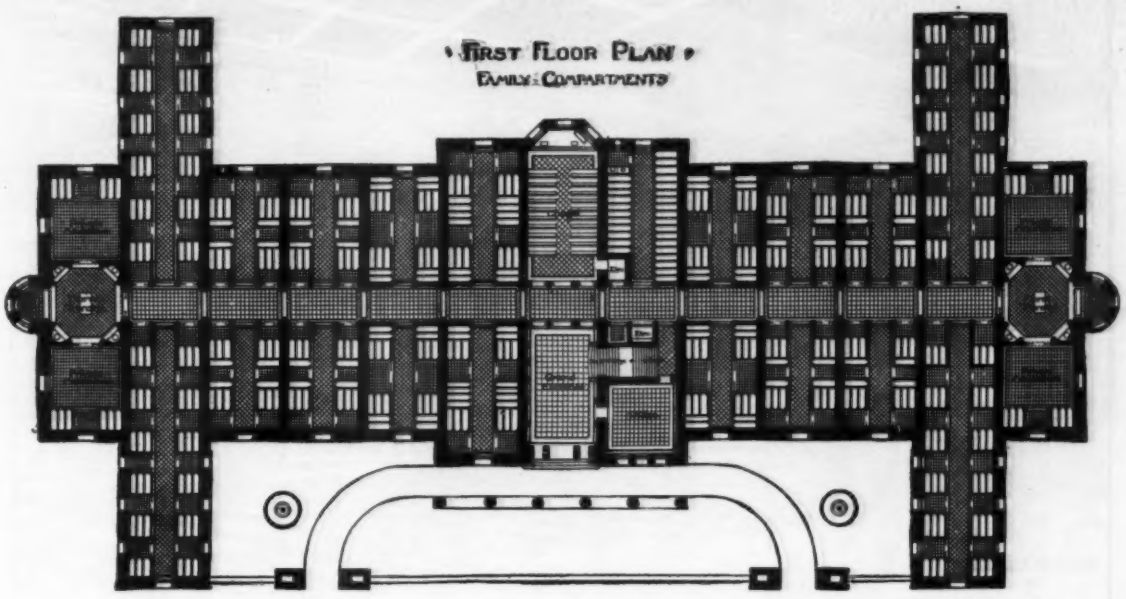
The new mausoleum makes impossible so sad a sequence to the discharge of the last duty to the dead. A beautiful chapel will be provided in each mausoleum, where the last funeral rites may be held, after which friends may lay their dead to rest under as congenial conditions as a loving mother can lay her child to rest in her own home.

The sepulchers will be numbered and registered in the same manner as are lots in a cemetery, and deeds to them, when executed to purchasers, will be countersigned by a trust company, and this trust company will be required to retain a stipulated sum from the sale of each sepulcher for the purpose of creating a sufficient fund, the income from which (after all spaces are sold) will be ample to provide for the perpetual care of the mausoleum, so that whatever sepulchers may cost, or wherever they may be located, all will have equal security, care, and protection.

Records will be kept within the mausoleum of all those whose remains are entombed, including birth, parentage, marriage, issue, time and cause of death, and such other facts as are important, and, as the building is fire, time, and burglar proof, these records will be imperishable, and will, in time, become of incalculable value.

A well spent life should not be wholly forgotten. Nevertheless, it is estimated that the average remembrance of those who have departed this life—the famous and the great as well as the obscure and humble—does not exceed the span of a single life. In a few years we are all forgotten! But this could not be the case with those who sleep in the new mausoleum, for no inscriptions or memorials there could be obliterated by the tread of the indifferent, or erased by the elements, or disturbed by the curious or malignant. The permanent care fund for the building would also provide for the preservation of the inscriptions and the renewal of the records, and the term of human remembrance, now so limited, would become a period, perhaps, beyond the ken of our race and country.

By the adoption of this plan, all classes can be entombed in mausoleums of far better appointments, and maintained under far better conditions, than those which entomb the remains of princes, heroes, or millionaires. It is really a safe depository, in every sense those two words imply, for the remains reposing in it. Having but a single entrance, inaccessible in any other way, and this one entrance will be constantly and perfectly guarded against intrusion or attack.



FIRST-FLOOR PLAN—FAMILY COMPARTMENTS IN NEW MAUSOLEUM IN THE VENETIAN RENAISSANCE STYLE.

17. It does not confiscate large spaces of the earth's surface that are or may be needed for business or economic uses.
18. It does not leave the remains of the dead where time and the tread of strangers can obliterate their memorials and resting places.
19. It does not store up germs of disease and death, which congenial circumstances will develop and use again to scourge the human race.
20. It is not repulsive in itself or injurious to the living.

The interior plan will resemble that of a well appointed library, with its main corridor and diverging halls leading to the different sections.

The sepulchers, of solid concrete, four inches thick, without seam or joint, of the proper size to receive caskets, are arranged in tiers of six upon either side of the hallways.

The opening into each sepulcher is provided with two doors. The inner door of plate glass will be hermetically sealed as soon as the space is occupied. The outer door may be of highly wrought gold, silver, bronze, or ornate stone, and may be decorated with sculptures or inscriptions, or adorned in other ways, in accordance with the desire of surviving friends.

As may be seen from a glance at the floor plan, a portion of each new mausoleum will be especially arranged for the accommodation of families. There will be separate and distinct compartments of various sizes, with sets of sepulchers, which may be finished with polished marble, onyx, or other precious stones, in artistic designs, or otherwise beautified, in accordance with the taste of the purchaser.

Surely nothing can be more comforting to bereaved friends than to possess so beautiful a resting place, in which they can leave the remains of their loved ones,

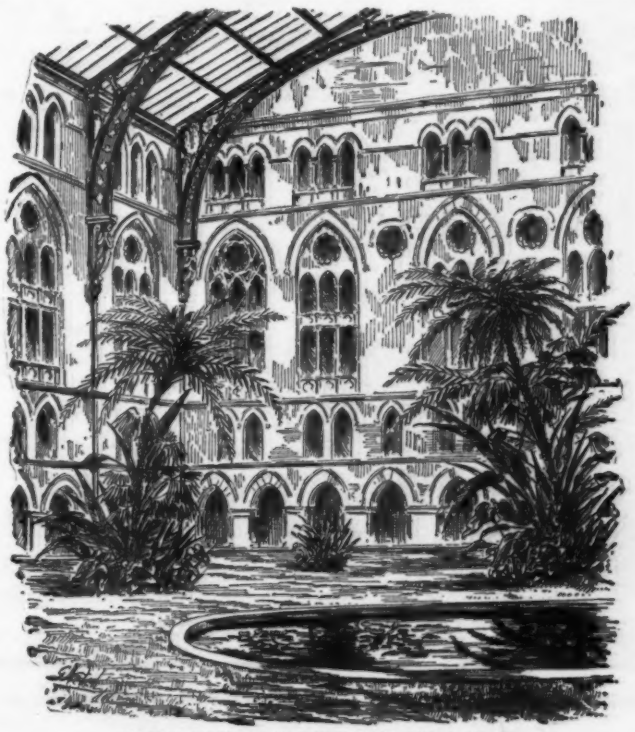
The sepulchers are constructed with conduits, so arranged as to bring fresh air into them and conduct it through the casket space by forced draughts to a furnace in a small building detached from the mausoleum. To that furnace the gases and vaporized fluids of the body are thus borne and there consumed. The escape into the atmosphere of any noxious matter is impossible. The air current is sufficiently rapid to make a frequent change in the contents of the casket space.

This smaller separate building will be in harmony as to location and architecture with the mausoleum, and will contain, besides the furnace, the appliances for lighting and warming the mausoleum, and also a number of sepulchers for the sanitary care of the dead, for whom no permanent resting place is ready, who are in transit to other points, who have died unknown and await the recognition of friends, or who have been disinterred with a view to entombment in the mausoleum. By this last provision all special cases will be cared for, particularly those undesirable to admit at once into the mausoleum proper.

The undertakers of every locality where new mausoleums are erected will furnish caskets adapted to the new process; and, before placing the remains in the space allotted, the ends and upper portion of the casket will be removed, the lower part of the casket being so constructed and the clothing so adjusted as to permit the freest circulation of air about every portion of the body.

Human remains so treated will become naturally desiccated, and will be preserved in that state for all time. The process and its results fully meet the most rigid sanitary demands.

The new mausoleums will occupy, comparatively, a



INTERIOR COURT OF THE NEW YORK CAMPO SANTO.

very little space; and, while they would be entirely unobjectionable in their appearance or effects, even if located within the heart of a densely populated city, yet the sentiment that the last resting place of the dead should be in a quiet, secluded spot, ought to be respected; hence it is advisable that they be erected either in or near cemeteries. But in any event they should have ample grounds and beautiful surroundings of their own.

A new mausoleum, 100 feet by 100 feet, could contain 10,000 sepulchers; and one that occupied an acre could provide as many resting places for the dead as a cemetery containing thirty-five acres.

The cost of everything is best appreciated by comparison. The cost of burial lots in the cemeteries around our principal cities, each containing space for six graves, is from $400 to $5,000. To this must be added the cost of inclosure, of head and foot stones, and of monuments, which will vary from say $100 to $50,000, according to the taste and wealth of the owner—all of which are exposed to the elements and in time become exceedingly unsightly.

Private mausoleums are often erected at enormous cost, and yet the most costly may be, sanitarily, more objectionable than the pauper's grave, and the best of them have none of the advantages herein described. Prior to the invention of this system, wealth could not purchase what it affords.

A new mausoleum may be constructed and arranged to meet the requirements of persons in all stations of life. It may contain elegantly finished family compartments, with six or more sepulchral spaces in each. The prices of these family compartments will vary from $600 to $40,000, according to location, finish, and space occupied, and in addition to their many advantages, which cannot otherwise be secured, they will be far more elegant than any private tomb can be.

Sepulchers may also be had singly or in groups, the price ranging from $40 to $300 each, according to location and finish.

Elevators, wholly of iron or other indestructible material, will make all the floors equally accessible.

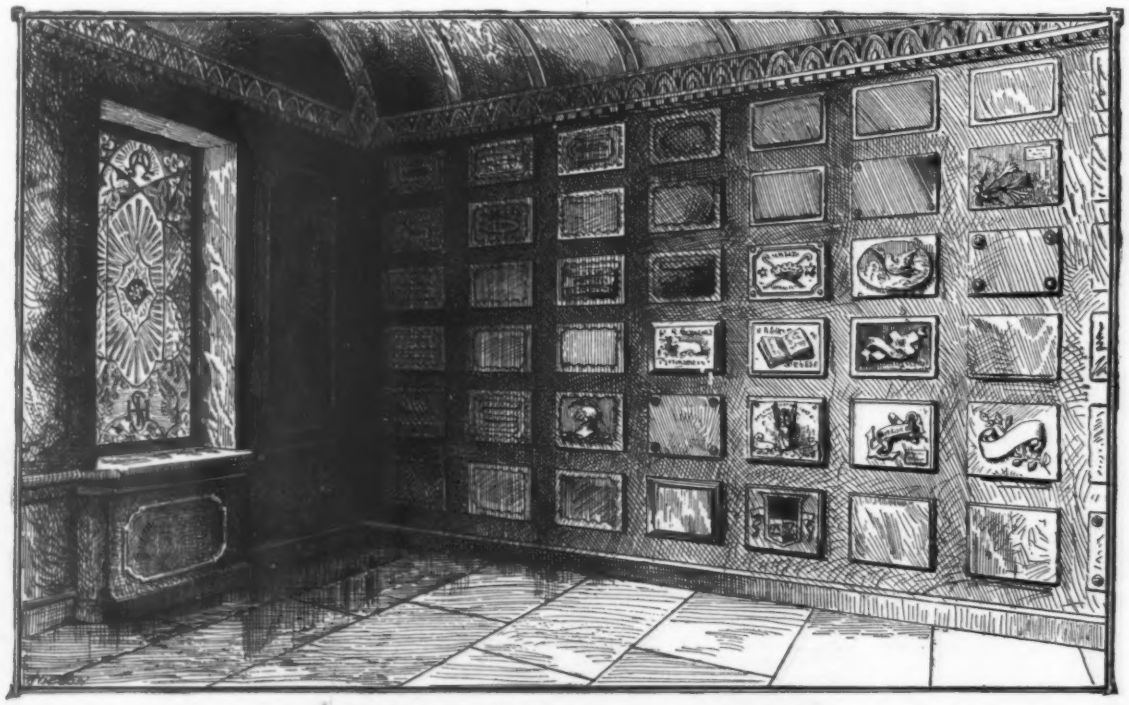
Parlors and retiring rooms will also be provided with every other convenience and appliance that can make the visits of surviving friends to this home of their dead comfortable, wholesome, and unrepellent in every respect.

Much time and money have been expended in perfecting and demonstrating the practicability in use, and certainty in result, of the system herein described. The highest authorities upon this subject and many persons of intelligence and high standing in the professions have been consulted, and in every instance, after full examination, they have heartily approved of this method, and given it their cordial indorsement.

Therefore the leaders in this new movement now present it to the public, confident that, as soon as it is understood, it will be everywhere discussed with great interest, and meet with universal approval.

It is a splendid edifice, which will have appointments and advantages such as no mausoleum has heretofore possessed. It will have features of so great desirability as to cause it to be welcomed with a sense of unspeakable relief from the painful apprehensions which are associated with, and inseparable from, other systems of sepulture. It will be a building grander than those in which kings have been entombed, and will be free from every taint or trace of the decay and decomposition which have made the tombs of the past repulsive to sense and thought. Such a building will admit, both without and within, of a wide range of architectural adornment. The wealth and the taste of a city or community will alone limit its extent.

A SINGLE GROUP OF SEPULCHRES



APPEARANCE OF THE SINGLE SEPULCHRES, WITH SUGGESTIONS FOR INSCRIPTIONS AND DECORATIONS.

We present several illustrations of "New Mausoleums."

THE strongest wood in the United States is that of the nutmeg hickory of the Arkansas region, and the weakest is West Indian birch. The most elastic is the tamarack, the white or shellbark hickory standing far below it. The least elastic, and the lowest in specific gravity, is the wood of the Ficus aurea. The highest specific gravity, upon which in general depends value as fuel, is attained by the bluewood of Texas.

THE FACE.

By A. H. THOMPSON, D.D.S., Topeka, Kansas.

THE human face is said to be the mirror of the mind, because it reflects not only the static intelligence and refinement of the mind, but also betrays its transient emotions and passing impulses. It is a matter of common observation that education, refined associations, and intellectual occupations, by elevating the mind, refine and spiritualize the face, in token of the refinement of the soul behind it. Thus the faces of persons with truly great minds—authors, artists, orators, statesmen, etc.—betray their greatness and are an attractive study to persons of sympathetic intelligence. The faces, for instance, of Cardinal Newman, Savonarola, Gladstone, Lincoln, are beautiful even in their homeliness, because of the great souls which have stamped them with the seal of superiority. In ordinary life we recognize a good face as betokening a good heart, and are instinctively drawn toward it. When such a one possesses a high intelligence also, we look for a perfect man—one to trust and obey, for of such are they that lead men and move the world.

Of course there are exceptions to this rule. Refined faces are sometimes found among people of low intelligence and brutal tastes; but these are erratic and only indicate minds which by proper development amid favorable environments might have grown to something superior. They merely mean native superiority, latent and undeveloped. Or again, persons of education and refined associations sometimes have brutal faces, but these are only examples of misplaced education, the natural instincts not being of the high order that give the best results by training. But these are only exceptions to the general rule that a refined and spiritual face indicates either inherited or cultivated superiority, or both together.

It has been observed that faces grow in refinement as the mind develops. This is especially noticeable in schools and colleges, when the coarse, animal features of the child unfold and bloom into refinement and beauty as the education progresses. The face refines

as the mind develops. And the person devoted to an intellectual or spiritual life reflects that life in his face, which grows more and more refined and beautiful as he pursues his elevating occupation and develops therein. The best examples of this development are found, of course, in those in whom the natural bent of the mind is favorable to such influences. Where it is unfavorable, the best of influences make but little impression.

Heredity has much to do, of course, with facial beauty and refinement. Generations of cultured associations and education will naturally produce faces of innate refinement and spirituality. If the course of such a life in a family is uninterrupted, it will lead more and more to beauty and refinement of features. But it is, unfortunately, rarely uninterrupted. There is degeneration in nearly every generation, either through crossing with coarser stock, or lack of education or moral influences or cultured associations, or the demoralizing defects of dissipation or low pursuits. So it comes about that coarse and refined faces occur side by side in the best of families, and often also in the worst. A refined face may appear in a coarse family or a coarse face in a cultured family, through the workings of the law of atavism. That law will account for a low and brutal mind, a black sheep, in the best of families, or of a refined individual in an uneducated and coarse family—the reappearance of former conditions. Such reappearances are due entirely to hereditary causes, and are in no case sporadic or accidental. Nature always works by law.

When we reflect that it is but a very few generations since our ancestors were savages, and that the length of that savage life was incalculably long as compared with the brief span covered by the civilized and historical era—during which countless impressions, physical and mental, were stored up and made permanent and transmissible—it is small wonder that low and animal instincts and tastes are so paramount in our lives. It is these impulses, coming from that long and dreary savage life, that we have to combat continually as we strive after a higher life. It was during that period that the mind of man was evolved and differentiated from the mental organism of the mere brute. With the evolution of the mind the face was developed and humanized, and as it receded from the animal face it approached a higher form, because it was the index of a soul. The face of the lowest savage man is little above that of animals in expression (except of superior mental power), because the higher mental qualities and emotions are yet dormant. As he emerges from savagery into barbarism he begins to feel somewhat for others, acknowledges that others have some rights, and from this stage the emotions are developed and his subsequent refinement and elevation are assured. The mind attained its full natural growth in savagery, and what it has advanced since then is merely by means of the artificial culture which has been superadded. So it is that the face has undergone but little change in historic ages, except in refinement by reason of the cultivation of the mind. If the child of any of the civilized races of man be reared in savagery without education, he would be but a savage yet.

With the birth of the emotions a great step forward was taken in the development of the face, for the emotions have much to do with facial beauty. A high intellectuality alone will not make a refined and beautiful face. Such a mind must be wedded to a warm heart to sanctify its mere strength. The noble impulses of great minds come from good hearts that prompt them to say and do great things for mankind. Lincoln's great deeds and sayings were due to his goodness of heart more than to strength of mind. Napoleon was great in generalship, and by the brutal strength of his mind he plowed his way through men and left death and misery in his path. Being heartless and selfish, the world despises him as a man and scarcely cares to admire his genius. With the greatest men of the world, as well as in ordinary life, it is the man who is kindest and best that has the most influence with his fellows. The growth of the good and elevating emotions has a refining effect upon the face and measurably atones for the absence of education or mental strength, which sometimes weakens a face. Good emotions are, in fact, the main factors of spiritual beauty, but as the animal selfishness which we have inherited from our savage ancestors is yet the mainspring of most of our actions, it is little wonder that there are few faces that are beautified by this reflected unselfishness.

The struggle for existence in our selfish commercial life is quite as fierce as in the days of the mere physical struggles of our ancestors, the fittest in physical prowess survived then, and the fittest in commercial shrewdness survive now. There is the difference, however, that the unfit are cared for to some extent by the more fortunate in our day, especially when intellectually or spiritually superior. But the financial conflict, and the grinding care this conflict brings upon all classes, weighs down the minds of men and furrows the face with lines. The daily anxiety about the means of living does more to destroy facial beauty than grief or suffering. It springs from and fosters selfishness and misanthropy, and crowds out higher thought and better emotions. It is this care and anxiety that destroys all traces of beauty, either natural or acquired, in ordinary faces. Surely civilization has done little for the struggling masses—better the communism of barbarism than this soul-destroying conflict and anxiety.

And yet there are some beautiful and spiritual faces to-day—the reflection of lofty minds and souls on which the sordid cares and anxieties and selfishness of life seem to have had little effect. They are such as have been saved by circumstances from toil and anxiety, and are thereby enabled to give their thoughts to lofty themes, or those who by temperament are oblivious to care and carry the burdens of life lightly, or of those who by strength of mind ignore the petty things of life and live in a world of their own; or, more rarely, a face is illuminated by a soul lit by divine fires, and tells of a spirit not of our poor, common humanity.

But the faces worth looking at and analyzing occur as rare oases in the desert of mediocrity around us, and serve but to redeem the mass from total condemnation.

Although the majority of faces as we meet them are hopelessly mediocre, and some even repulsive, such as they are, it is our professional duty to study them, by reason of the relation of dental science to the outward face and the effect of our art upon it. Our work often has a perceptible effect upon the features, and some branches of it, especially orthodontia and prosthesis, often cause a revolution in the expression of the face. So we have powers to alter even the mediocrity which we daily meet, and the effect of our operations upon a fine and sensitive face is too often startling. So few faces have any visible soul in them that the attempt to produce any artistic effect is disappointing and disheartening.

This is one unrecognized source of the low grade of artistic prosthesis that prevails—*i. e.*, expressionless faces cannot be reanimated by any resources of our art, and by our failures we are discouraged, when the cause of our failure is really not lack of skill.

The anatomical relations of the face are very simple, and beauty, so far as dental resources and the influences of our art are concerned, depends largely upon its mechanical elements.

There is to be considered the proper proportion of the different sections and areas of the face, the exact proportion and harmony of the features, the proper amount, without excess, of upholstering and padding by adipose tissue, the texture and color of the skin, etc. From the mechanical standpoint the main elements of beauty are proportion, contour, and color, and from this basis the dentist must view the face, for his resources are purely mechanical. He might like to put more soul into a dull face by way of completing it, after he has done his artistic duty, but he cannot do it. If the gods have omitted that important factor in the composition of the individual, it is not for any finite dentist to remedy the omission.

The artist or sculptor may spiritualize a face, but the dentist, the humble worker on the natural clay, cannot aspire to such divine work. Hence his heart is often saddened by disappointment when his best efforts have been expended in the futile endeavor to elevate a face nature has neglected.

From the standpoint of the mere artistic mechanics of the subject, when we study the faces we meet in practice, we observe that there are very few that are properly proportioned according to exact rules, that most faces are more or less asymmetrical, and that facial deformity is the rule. It is the exception to see a face in which the features are in harmony and proportion. This is probably largely due to the heterogeneous mixture of races and types.

This racial intermixture prevails so extensively in this country that inharmony of feature is the rule, for very few American faces are well composed. This inharmony will continue until foreign influx ceases and prevalent types are developed.

Inharmonious features crop out in many faces, and are out of harmony because of a very different type. Or, again, two or more types may be represented in a single face. A feature may be fine enough of itself, but if of a different type from the rest of the face, it is out of harmony and becomes a deformity, whereas if it were set in the midst of harmonious features of its own type it would be beautiful.

For instance, the nose is often out of harmony with the remainder of the face, being either too large or too small, or of such shape or expression as to be out of all relation to the prevailing type of the face, and that in that setting it is a deformity.

The mouth, also, is often inharmonious. A thick-lipped, sensual mouth set in the midst of a refined, spiritual face strikes all observers as being a ludicrous combination.

A weak and receding chin accompanying a strong upper face is painfully incongruous; but in the male sex such a deformity can be concealed by the beard, which often gives a face a dignity it would not otherwise have. Nearly all faces have one, two, or more features of different types from the prevailing type of the face. Harmony of type in all the features is a rare good fortune in a heterogeneous people.

Much depends upon contour for beauty of the face. Youth is the season of freshness of beauty, as the face is then full and well rounded. This beauty of contour is produced by adipose tissue, and as age progresses this disappears, the features shrink and lose their expression, the muscles become less mobile, the skin loses its youthful color and texture, and as the years toll off, the face assumes more and more the shape of the bony framework beneath, betraying approaching dissolution. Then, again, the experience of the years leaves its marks.

The face in age may be serene and placid, or plowed with the furrows of suffering, as the life may have been happy or otherwise. Disease may also cause the face to shrink prematurely and reduce the contour by emaciation.

This, however, is usually corrected on the restoration of health by the redeposit of fat, except in the case of chronic disease and insufficient nourishment of the tissues. Contour is a principal element of beauty, in a mechanical and artistic sense, and other things being equal, the plump face is the most agreeable and attractive. A certain amount of fullness or tissue body is necessary for the proper support of expression, for shriveled features cannot be expressive and active in conveying the workings of the mind.

Therefore, in the restoration of expression, within the limits of his art, which is altogether mechanical in its effect, the dentist has in view the plumping of the shrunken face with the object of restoring the features to their proper contour.

There are many abnormal causes of facial deformity, and among these dental irregularity stands prominent. On account of insufficient room or other causes, the incisors may be crowded and forced forward, thrusting out the lips and producing an abnormal expression of the mouth. Or the V-shaped jaw may mar the strength of a face and give it an imbecile cast. Or the cuspids, by erupting forward of the dental line, may give a ferocious expression to a mild face. Premature extraction of teeth may lead to contraction of the jaw and asymmetrical development of the face. The removal of the cuspids causes a depression in the line of the canine eminence and a sinking of the face quite up to the alæ of the nose, with a consequent destruction of symmetry.

Many other forms of dental irregularity affect the features and mar the beauty and symmetry of the face in greater or less degree.

Disease often has a directly deforming effect also. Thus, hypertrophy of the tonsils is sometimes accompanied by mouth-breathing and compression of the alæ of the nose and narrowing of the bicuspid region of the face, thus producing an abnormal conformation.

Nasal catarrh sometimes causes distention of the nose, with disagreeable disturbance of the harmony of the face. Affections of the breathing apparatus causing distress and effort in breathing lead to distressed expression and straining of the features, and may produce permanent contortions from spasms. Chronic diseases of other organs, especially of the heart or stomach, often give rise to peculiar expressions of distress or anxiety which may be pathognomonic.

Nervous diseases, paralysis, etc., of course, often have a direct effect in producing contortions of the features, and physical pain from any source is always indicated by the faithful reflector. But yet again we sometimes see persons in whom prolonged suffering and an invalid life lead to such serenity of mind, by the contemplation of lofty themes and the cultivation of religious devotion and resignation, as to ennoble and spiritualize the face and give it a mysterious and wonderful beauty.

There are exceptions, of course, to the average, for as a rule the cruel hand of pain scars the face with the too evident signs of its presence. Suffering, indeed, usually alters the whole character of the individual and makes him better or worse. It lowers or elevates the soul, and the face reflects the changes.

But let us turn from these disagreeable considerations to the contemplation of the beauties of the face for their own sake. Beauty everywhere is for enjoyment. Nature created beauty to excite pleasurable emotions. It never ministers to misery or pain. So, indeed, a beautiful face is created to be admired and enjoyed.

The first thing that strikes us favorably in a face is exactness of proportion, and then harmony of the features, whatever the type. These give pleasure to our artistic sense, be it crude or cultivated, for the artistic sense is innate in all men.

We enjoy a beautiful face, be it young or old, man or woman, as other beauties in nature or art, with an additional pleasure from the consciousness of it being living beauty and that it is animated by a soul behind it whose beauty it reflects. So in the beautiful face of a child it is the innocence and joy and freedom from care that the face reflects that attracts us, while we admire the mere form and contour and color. So also with the face made beautiful by intelligence and spirituality; we enjoy the contemplation of it for what it represents, and it lifts us above our sordid selves. The ethical effect of this spiritualized beauty in man or woman has a powerful influence for good, and it is felt by all men more or less consciously.

A good face does good by its mere presence among men, and the influence of such a person cannot be estimated. But facial beauty is so varied, and standards vary so much, that taking all classes and tastes, perhaps there may, after all, be very few healthy faces that are not attractive and more or less beautiful in some eyes—dull and commonplace as the majority of them appear.

But still another source of enjoyment of beauty of the face is given us in sculpture and painting. There it is usually idealized, so that we have, in a certain sense, a higher expression than in the living face. In antique sculpture the faces are idealized to represent the high conceptions of gods and heroes, and there is a dignity and grandeur in them not approached by any human faces. In the religious portraits of the old masters we have other ideals which are more than human.

The faces of the saints are animated by devotional ecstasy, and vividly represent the mastery of pious thoughts and ideas. In later art there is the idealization of various great conceptions in the sculptured or painted face.

All art, in fact, illustrates the expressional possibilities of the human face as a vehicle for the portraying of high motives and lofty themes, that move men and lift them from their grinding lives to spheres of spiritual and ideal life.

Beauty everywhere, and artistic expression of its highest forms, seems to feed, if not satisfy, an indescribable, artistic longing, and brings us nearer to those dreams which sometimes flash upon us like memories of the beautiful seen in other worlds.—*Dental Cosmos.*

[NEW YORK TIMES.]

BRAZIL.

WITHIN a few days reports will be received from Brazil giving the details of the revolutionary movement. To enable the readers of these reports to understand their purport and meaning, it is necessary that they should have a more accurate idea of the geographical and political conditions of the country, generally speaking, than is usually found in the books to which recourse may be had in our libraries, and which it is practically impossible to find in any of the books of current circulation.

In my visits to the chief Brazilian cities I was struck with nothing so much as with the difficulty one encountered in securing statistical data and in finding books either great or small which contained information that a serious investigator of either political, financial, or commercial questions would most wish to encounter.

So far as geographical Brazil is concerned, the best book now extant is one published by Brockhaus, in Leipsic, in 1889, written by M. T. Alves Nogueira, entitled "Compendio de Geographia e Chorographia do Brazil." And so far as concerns the form of government which has just been abandoned, I know nothing which summarizes it so well as the annual chapters in the "Statesman's Year Book." Although the book has now become somewhat post-dated, the chapter on Brazil in Gallenga's "South America" is one of the most valuable single chapters I know of, and is full of interest as summarizing the conditions of the government looking toward a future possible republic.

The vastness of the Brazilian territory is too little appreciated. It is as large as the entire territory of the United States, provided Alaska be not taken into consideration. It has a coast line of 4,000 miles; from Pernambuco to its Andean frontier is some 2,400 miles. This vast territory has been estimated to be about one-fifteenth of the surface of the earth not covered by

water. When this vastness is borne in mind, and when it is remembered that the country is much in the position that the United States was in immediately after the Louisiana purchase, or say at any time prior to the construction of the great transcontinental railroads; that as between thickly populated points there existed almost impassable mountains or forests of inconceivable density and almost endless extent; that North and South Brazil have between them absolutely nothing in common except their language; that there are no railroads whatever which traverse the country throughout its length in any direction, that the telegraph system has been little developed, and that coastwise commerce even is as yet very incompletely developed, it will be realized how difficult of establishment a cohesive federal republic will be, and that the great danger which attends the present enterprise is the breaking up of Brazil into a number of republics.

Any one who is familiar with the great coast cities discovers very early that not only their own particular interest takes precedence of all other interests, but that so far as Para, Pernambuco, Bahia, and San Paulo are concerned, the people in these places all resented the great centralization of interest at the national capital. The feeling for provincial autonomy, which is one that gave the imperial government much trouble during the last years of its existence, is very strong, and may lead to the establishment of a number of independent states. On the other hand, the bonds of tradition and language may be sufficiently strong to hold all together, and ultimately weld them into a single immense federation. The great question is, Who is in command of the movement in the different provincial capitals?

If the church were really an organism full of vitality and vigor, with complete and perfect co-operation among all the members of the hierarchy, this also would be conducive to the maintenance of unity. Such, however, is not the fact. In Brazil, the church, as it is in all South American countries, is in large measure a mere dependency of the state. We should at all times avoid falling into the error that anywhere in South America the church enjoys the immunities from state interference which it possesses in the United States. Only such persons can become bishops as are satisfactory to and meet with the approval of state authorities. As between the different dioceses there is no very strong common interest. The influence of the church is confined almost exclusively to the poorer and less intelligent classes. And the press, which is very much below the level of the press of our greatest cities here and in Europe, is nevertheless quite on a plane with the average provincial press of the world, is the largest educator, and is almost entirely emancipated from the influence of the church. There are 236 ecclesiastical divisions, with eleven bishops and one archbishop. And these divisions are, generally speaking, coterminous with one or more provinces, so that they do not constitute in any practical sense cross divisions with the political divisions of the country.

In order to get a more complete and accurate view of the vastness of the Brazilian territory, the provinces should be taken up in their order, it being borne in mind that the whole territory is in extent some three millions and a quarter of English square miles.

Let us begin with the province of the Amazonas, which lies at the head waters of the Amazon, on either side of the river, from the Rio Negro west to the Peruvian frontier. Its area is 1,897,020 kilometers, or somewhat over 753,000 square miles, which is equivalent to one-fifth of the territory of all Europe, or say which is equal to all of France, Italy, Spain, and Portugal. Its population is estimated at 100,000 inhabitants. Manaos, with 6,000 inhabitants, is its largest city. There are two towns of 4,000 inhabitants, one of 2,500, and three or four of 1,000 each. Manaos is the capital, standing at the junction of the Rio Negro and the Amazon. The principal business of the place is in rubber, cacao, sarsaparilla, tonca beans, and nuts. Regular lines of steamers run up the river from Para to Manaos. In fact, the river is navigable as far as Manaos by ocean steamers, and from Manaos smaller steamers run up the river as far as the Peruvian frontier. It should be borne in mind that the Amazon and its tributaries constitute a system of navigable rivers in all over 24,000 miles in length, or say as long as the circumference of the earth.

The province of Para lies on either side of the Amazon from the Rio Negro down to the sea. The territory is 1,149,712 square kilometers, or say 412,000 square miles, which is equal to France, Spain, and Portugal in size. The population is between 300,000 and 400,000 inhabitants. Its capital, Para, or Belem, as it is called by the Brazilians, has a population estimated at from 40,000 to 60,000. The next largest city is Camata, with 5,000 inhabitants. Tapajoz, with 4,000 inhabitants, is the only other large town in this great region. Para is the central distributing point for the entire Amazon valley, and consequently a large commercial center. It exports all of the products of the Amazon, rubber being its chief item of exportation.

Now, following down the long coast line of 1,000 miles, you find immediately south of Para the province of Maranhao, extending far into the interior, at points as far as the Tocantins River, with a territory of 459,884 square kilometers, or say about 141,000 square miles, or about five times as much ground as is covered by the kingdom of Portugal. Maranhao, or San Luiz, is its chief city, with about 35,000 inhabitants. The city has a good port, the channels of which are now, however, filling rapidly. It used to be a very important mercantile center, as being the point of distribution for the Amazon valley, from which position it has, however, been ousted by Para. As a consequence, during recent years the population has been shrinking, and all signs of activity and bustle have departed from this once energetic center. The entire province is little more than a continuation of the Amazon valley. Its population has approximately half a million people. Its chief products are cotton and sugar. There is only one really important city, the capital, in the entire province.

Next below Maranhao is Piauhy, with a territory of 391,797 square kilometers, or say 81,776 square miles, which is a little less than the British Isles in size. It is in this province that we begin to find the foothills of the great central range which extends north and south parallel with the Brazilian coast from Cape Sao Roque to the southern boundary. The population is not quite a quarter of a million. It has one town of 10,000 inhabitants and another of 6,000, with little or no commerce of any kind.

Ceara lies east of Piauhy and immediatly north of Pernambuco. This is a little triangular province of 204,150 square kilometers, say 40,000 square miles, with a population of three-quarters of a million. Here for the first time we find cultivation of coffee on a fairly large scale, cotton and sugar being also among the chief products. The country is very fertile, but has of recent years suffered terribly from drought, so much so that the Brazilian government, to meet the demands of the starving population, has moved the Cearenses in large bodies into Para and Amazonas, where they are treated as immigrants, and where the national government, together with the provincial governments in the Amazon valley, offer not only immediate assistance, but large ultimate inducements.

Rio Grande do Norte has about 20,000 square miles; is about the size of Greece, and has a population of 269,000. This, also, is a cotton and sugar country. Its largest city is Natal, of 12,000 inhabitants.

Parahiba do Norte is about the size of Scotland. Its physical conditions are practically the same as those of Ceara and Rio Grande do Norte; low land, rising gradually from the sea to the mountain summits, more than two-thirds of it being very mountainous and rolling. It has a population of about 433,000, Parahiba, the chief city, having only 15,000 inhabitants. Its principal products, like those of its neighbors to the north, are sugar and cotton.

Pernambuco, which is one of the most flourishing provinces, has a territory about one and one-half times as large as Portugal. It is not usually realized that this point is only four short days' sail from the African coast, which accounts in a great measure for the ease with which the negro population there get into Brazil. It has a population of 1,014,000. It produces sugar, coffee, cotton, and tobacco. The city of Recife is estimated to contain about 130,000 inhabitants, and is a thriving, cosmopoli an, and wealthy place.

Alagoas has 58,491 square kilometers, or a little over 22,000 square miles—say two-thirds the size of Portugal. The best part of the little territory has an alluvial soil, which yields sugar, cotton, and tobacco. It has an estimated population of 397,400. Its two largest cities have 10,000 each.

Sergipe is about the size of Denmark, and is the smallest of the Brazilian provinces. It has a population of 211,000, and is also a cotton and sugar country. Its capital has a population of 6,000.

Bahia is one of the most important of the Brazilian provinces, its chief city having one of the finest harbors on the entire coast. It is about three times the size of England, a rolling country, with great valleys and high mountains. The city of Bahia has 140,000 inhabitants. It is the center of a very active business. The American and many European steamers put in at this port, as they also do at the port of Pernambuco. This is the province which supplies Brazil with the greater part of its tobacco. It has important salt mines. It yields a considerable crop of sugar and cotton, and is one of the centers of intellectual and political activity in the State.

Espirito Santo is a litle smaller than Switzerland, running back from the sea to the maritime chain of mountains. It has also a sugar, coffee, and cotton belt. It has no large cities, its largest having but 5,000 inhabitants; the population of the whole province being only 100,000.

Rio de Janeiro is a little larger than Holland and Belgium. It has a population of 938,000. Its capital is the city of Nichteroy, with 20,000 inhabitants. Campos is the next most important city, which has 20,000 inhabitants also. Sugar, coffee, rum, and wood constitute the agricultural staples of the province. Valenca has 10,000 inhabitants. There are no other places which deserve to be called cities.

Municipio Neutro corresponds to our District of Columbia. It is independent of any of the provinces, the national capital, Rio de Janeiro, being its great city. The city of Rio is variously estimated as having a population of 359,000 to 500,000.

San Paulo, lying still to the south and along the coast, is to-day the most active, progressive, and energetic of all the provinces. It has a population of about 1,100,000. It is about as large as Italy. Here coffee is king. The city of San Paulo, of 50,000 inhabitants, is the capital, and is a very liberal and modern city, its market and streets having all the movement and activity that are to be found in a great center like Buenos Ayres. Santos, with 14,000 inhabitants, is its chief port. Campinas, up to a year ago, had 12,000 inhabitants. The yellow fever of last winter virtually depopulated the place. There are several cities with a population of about 5,000.

Parana is about as large as Sweden, or five times as large as Switzerland. The population is about 200 000. Its principal product is mate, better known as Paraguay tea. It has no large cities whatever.

Santa Catharina is about the size of Scotland; it has 200,000 inhabitants. Desterro, its capital, has 8,000 inhabitants. It has no other large town, the largest having not more than 2,000 inhabitants.

Rio Grande do Sul is say eight times as large as Belgium. It has nearly a million population. Porto Alegre, its chief city, has 40,000 inhabitants. Pelopas has 10,000 inhabitants. And after that there are no large towns. This is one of the most flourishing of the southern provinces. It touches the Uruguayan border. These provinces cover the whole coast line.

Lying in the interior back of Bahia and Rio do Norte, and north of San Paulo, is Minas Geraes, which is larger than France and Switzerland, with a population of 2,500,000. Its capital, Ouro Preto, has 20,000 inhabitants. There are a number of cities of from 6,000 to 8,000 inhabitants. The population is scattered thinly throughout the entire provinces. This is not only one of the richest agricultural countries in the world, but a country of great mineral wealth, being the auriferous region of Brazil, and also including the diamond mines from which much wealth was taken during the last and early part of this century. This is, like San Paulo, the great coffee center.

Back of this and beyond the central coast range lies Goyaz, which is eight times as large as Portugal. This is usually considered as the heart of Brazil. Its population is most thinly scattered and does not number over 200,000. We here find ourselves back again in the sugar and cotton regions. Its largest town, Goyaz, has only 9,000 souls. The next largest has only 3,000.

Beyond this, again, lies one of the greatest of all, the Matto Grosso, which is practically an unexplored forest. It is as large as France and Spain combined. Its population is estimated at only 72,000. Its largest town has only 12,000 inhabitants. It is practically an unknown country.

These provinces together, with all of their physical differences, running from the great valley country of the Amazon into the high mountain plateaus, crossed and recrossed by great mountain ranges, with almost every kind of climate and temperature, thinly populated, with no roads more than two or three hundred miles into the interior, with no system of highways whatever connecting one part of the country with another—so that it is impossible, for instance, to pass by land from Rio to the mouth of the Amazon without undertaking a journey which would require months for its completion and involve all manner of dangers and hardships—have now become the home of the newest of the republics. In territorial size it is only exceeded by the British Empire, by Russia, China, and the United States. Of its population of, approximately, 13,000,000, 51½ per cent. are males, 48½ females. These figures, however, do not include an estimated 600,000 of indigenous tribes. The great country embraced in Amazonas, Para, Matto Grosso, and Goyaz contains but 5 per cent. of the total population. The remaining 95 per cent. are found along the coast, which provinces cover but 38 per cent. of the whole national area. The population is of the most mixed kind possible. By the last census, the white population was put down at 4,000,000, of whom only 121,246, however, were entered as pure blood Portuguese. Probably 4,000,000 of the inhabitants are full-blooded Africans and the remainder a mixed race of every possible shade of color.

Systematic national education has been only slightly developed. The illiterate population is estimated at 80 per cent. The common people throughout the country live mainly upon jerked beef and manioca, this latter being flour made from the root of the manioca plant, which grows everywhere throughout the empire. Indian corn is raised in large quantities for home consumption in all of the provinces. It is planted on a particularly large scale in the south. The most important crop for the nation, from the point of view of international trade, is coffee. The average annual production of the coffee belt is somewhat over 400,000,000 kilogrammes, which is somewhat more than half of the entire coffee production of the world.

Sugar cane can be cultivated in all of the bottom lands, and cotton as well. In some of the provinces, particularly Bahia, St. Paulo, Para, and Minas Geraes, tobacco grows wild. In the south—St. Paulo and Rio Grande do Sul—grape culture has become an important industry.

In Southern Brazil cattle raising is also a widely extended occupation. It is said that there are something like 30,000,000 head of cattle in Southern Brazil. Horse and mule raising also receives much attention. The country is extraordinarily rich in its mineral wealth, although the mining belt has scarcely been explored. Iron exists in large quantities in the south. Coal and lignite is to be found in all the countries traversed by the mountains. Salt is scarce in most parts of the country, and such as is not imported from abroad, particularly all the salt for table use, is made from the sea water.

The aggregate length of Brazil's railways is only 7,063 kilometers. She has only 10,292 kilometers of telegraphic lines. Her mercantile marine is insignificant, consisting of only 190 vessels engaged in general ocean trade, and 1,600 small coasters. Her external commerce for the year 1887 was approximately $105,000,000 of imports and $132,000,000 of exports. For the last four years the interprovincial trade has averaged $65,000,000.

There are 8,651 schools, with 285,000 students; twenty secular colleges and lyceums, and nine religious seminaries. There are eleven theological schools and two faculties of law. At Rio there is an academy of fine arts, a conservatory of music, a commercial institute, and a Portuguese library. At Bahia there is a school of arts; at Minas Geraes a school of mines. There are military schools at Rio Janeiro and at Porto Delegua, and a military school as well at Rio. These figures differ somewhat from those in the Statesman's Year Book, and are taken from Noguera's.

Such, in short, is the country it is sought to govern in the future by purely republican institutions. Under the emperor the electorate numbered about 200,000. With an educational qualification it will, under the republic, number 600,000. The changes in the form of government need not necessarily be violent. The emperor steps aside, a president or dictator takes his place. The same people who have heretofore directed the destinies of the nation will continue hereafter to direct it, the body of great national leaders being the same to-day as yesterday. The electorate will be somewhat enlarged, but the direction of the affairs of the country will remain in the hands of the same governing class. The provinces will become, in all probability, states, corresponding to the states of our Union, with a danger constantly threatening the national integrity because of the vast distances which separate the provincial centers from each other and the looseness of the tie which binds the provinces together, for want of a wider education, a more extended inter-provincial commerce, and the absence of means of intercourse and communication.

The Brazilian army does not number more than 13,500 men. This is its nominal strength on a peace footing. The war footing of the army was 32,000. The navy contains several modern war vessels. Its nine ironclads, with its cruisers, transports, tenders, and eighteen gunboats, are manned by 5,788 officers and men, including marines.

The national debt at the beginning of this year was about £102,776,100, which includes the internal and the external debt, and the paper money, of which latter there is about £18,500,000 in circulation. This does not include provincial debts, which have been freely incurred during the past two or three years. The annual budget for national purposes averages 150,000,000 of milreis, or say $75,000,000. For many years past there has been a steady annual deficit, ranging all the way from $4,000,000 to $10,000,000. Heavy export and import taxes are levied for account of the national and provincial governments, these two taxes being the chief sources of revenue, the total rate of taxation,

either for export or import of any given class of goods, not necessarily being the same in any two provinces, because of differences in provincial laws.

Of the railway lines referred to, the state owns ten, of which about 1,444 miles have been opened. The chief of these is the Dom Pedro, which runs out of Rio. These ten state lines cost about £9,600,000—say $45,000,000—and yield a net revenue of about 3½ per cent. on their cost. Most of the railroads are built with government guarantees of interest on the capital, the rate being variously 6 and 7 per cent. The entire telegraph system of the country, with the exception of the cable lines, is under control of the government. There are only 170 telegraphic stations in the country. The postal system is undeveloped. Of the 13,630,267 letters which went through the post office last year, more than half came from the national capital. The parcels post carried only a little over 1,000,000 packages.

The presentation of these data should afford a basis for a more intelligent study of the news which will come to us of what has actually occurred in the country of which a concise description has here been sought to be given. The emperor once said: "If I were not emperor, I should prefer to be a school teacher. I know of no greater, nobler mission than that which directs young intelligences and prepares men for the future." It is to be doubted whether the emperor, having ceased to be such, will become a school teacher, but it is not to be doubted that the future of Brazil is really in the hands of the school teacher nevertheless.

WILLIAM M. IVINS.

THE PHOTOGRAPHING OF ARTILLERY PROJECTILES TRAVELING THROUGH THE AIR AT A HIGH VELOCITY.*

IN September last year some very interesting experiments were carried out at the range of the Gruson iron factories at Buckau Magdeburg by Herr Ottomar Anschutz, the well known expert in instantaneous photography, of Lissa (Posen), which proved by some successful impressions the possibility of photographing projectiles from artillery during their flight at high velocities. It is the first time within our knowledge that this problem has been attempted at all and at the same time solved.

Herr Anschutz by these experiments only wished to demonstrate that it is generally possible during the flight of a projectile to fix its image by daylight sharply upon a photographic plate, and this not only once, but in several consecutive phases, the number of which has been temporarily fixed at four. As these experiments were carried out at his own cost, Herr Anschutz found it necessary on account of the expense to limit in many respects the various ways of applying his method.

In taking impressions of bodies which are moving with great velocity, there are two difficulties to be overcome: the first, so to shorten the time of exposure that the object appears sharply defined; the second, to obtain the impression at the exact moment when the object arrives at a given point.

With regard to the first named difficulty, it is easily understood that, with increasing velocity in a moving body, it is necessary to shorten the time of exposure, as, if too long, instead of a clear, sharply defined picture, one crooked and elongated in the direction of its line of motion would only be obtained. In taking an impression of a projectile in flight, it is also to be feared that one would find upon the plate not a picture of the projectile, but one of its caliber. Herr Anschutz believes that for a velocity of about 400 meters a second the time of exposure must be limited to the extraordinarily short space of the 76 millionth part (0·000076) of a second. The projectile would in that time travel about 3 centimeters, and he therefore hoped that if he could fix his apparatus at a proper distance, and consequently diminish the visual angle, the projectile would appear upon the plate sufficiently sharply defined, or at most a little misty about the edges at the front and base.

In order to give the reader an approximate notion of what opening and shutting a photographic apparatus in the 76th millionth part of a second means, and during that time to take a distinct impression, it must be stated that in ordinary so-called instantaneous photography (of living moving objects, etc.) this time fluctuates mostly between the one-twentieth and the one-sixtieth part of a second, and has never as yet even been compressed within the one-hundredth part of a second.

The second of the difficulties already mentioned is known to any one who has at all busied himself with instantaneous photography. He will have learned how difficult it is, for example, to fix in the exact center of a plate a horse trotting past the apparatus. He generally exposes either too soon or too late. How much more difficult, therefore, must it be to deal with a projectile moving with a velocity of some 400 meters in a second, especially when the object field of the apparatus only covers about 15 meters. Herr Anschutz has, in order to meet the difficulty, so constructed his apparatus that the projectile itself, by tearing away a wire net, and by so doing breaking an electric current, brings into action an instantaneous closing arrangement, and in this manner, having due regard to the time which the release and working of the arrangement requires, the certainty is offered that the projectile will pass the field of the instrument at the exact moment when the mechanism for the instantaneous exposure and covering of the plate is brought into play.

The principle of construction of such an instantaneous mechanism for work of this kind consists, in the main, that a covering disk closing the lens, but provided with an opening at one spot, hangs before the apparatus; it is released by the breaking of an electric current, and when free must attain in falling that velocity which is required to correspond with not only the velocity of the moving projectile, but also the time of exposure rendered necessary by the sensitiveness of the plate, as well as the size of the opening, in order to obtain a clear picture of the flying projectile in the short time which elapses while the opening in the falling covering disk passes the apparatus. It is obvious that the bringing into agreement of all these factors, position and velocity of the flying projectile, the direction of the apparatus, point of time, and duration of the exposure of the plate, create no light difficulties in the practical working of the scheme; and the completeness of any apparatus constructed for this purpose will be proved by its surmounting or otherwise of these difficulties.

For the case under discussion the question in the first rank is the determining the time which elapses from the release of the disk already mentioned till the moment when the opening in it passes the lens of the apparatus with the necessary velocity, in order to be able to determine the exact spot where the impression must be taken. By application of the spark chronograph this time proved to be 0·28 of a second; in this time the projectile with a velocity of 400 meters a second traveled over 113 meters, and therefore the position for taking the impression was fixed for 113 meters in advance of the frame of the wire net, by passing through which the projectile itself released the covering disk before mentioned. At the height of this distance it was therefore necessary to fix on one side of the path of the projectile a white background, against which the flying shot is shown in sharp relief, while upon the other side of the plane, distant about 80 meters horizontally from it, is the position which ought to be assigned to the photographic apparatus.

Since Herr Anschutz intended to obtain an image of the shot at four different points, four apparatus were provided, which were so arranged that each succeeding one worked 0·009 of a second later than the preceding one. For the whole set of impressions, then, 0·028 of a second was required, in which time the projectile would travel about 11 meters. The background was in consequence of these 13 meters elongated, and upon it, below the line of the projectiles, a scale 13 meters long drawn, so that it would be immediately seen where the moving projectile was at time of each impression. Beneath the center and two ends of the scale three shots were securely suspended, in order to have a comparison of the pictures of the projectiles, both in motion and at rest, with each of the impressions.

Herr Anschutz had naturally so constructed his apparatus that it would suit any other approximately similar at least to those described, even if the conditions should be changed on account of the time of flight of the projectile; and it needs scarcely to be explained that in consequence of having to work with so minute a limit of time, an arrangement of the apparatus in connection with Siemens' spark chronoscope was necessary to determine the fixing and reading off the smallest units of time.

Unfortunately, the range of the Gruson factory at Buckau is extremely limited. So the experiments could not be carried out as completely as was intended. The working of the apparatus by the projectile itself could not be managed, as the distance of 113 meters for the projectile could not be obtained, and this was the distance necessary to correspond with the fall of the covering disk. As time was wanting, nothing else remained but to provide the necessary interval for the working of the instantaneous mechanism by arranging for the release of the disk at the beginning of the ignition of the charge, so that during its combustion the disk was already falling. By this arrangement it was necessary to take into account the irregularities which are unavoidable in the ignition and combustion of the charges of guns (which become of moment through the necessity which exists for the most exact agreement in the coming smallest particles of time); and so it resulted, unfortunately, that in two methods of ignition provided at the experiments, the one acted too slowly and the other too rapidly, with the result that the projectile had either not reached or else had passed the object field of the apparatus at the moment of exposure.

Nevertheless, he succeeded late in the afternoon in obtaining by means of the first apparatus a neat impression of a 25 centimeter long 8·5 centimeter projectile, and thereby proved the possibility of the experiment, although it was accidentally placed in a very unfavorable position in consequence of the position of a beam placed near, which threw a shadow upon the white background.

Unfortunately, also, the projectile had already reached the end of the object field, so that the remaining three impressions showed only the bare background with the scale and shot at rest.

Both by this one successful impression, as also by those attempts where the necessary agreement between the flying projectile and the working of the apparatus was not obtained, it resulted, nevertheless—and this is conclusively the essential fact in regard to the photographic impressions—that with tolerably good sunlight even the uncommonly short time of exposure of 0·000076th part of a second suffices completely with an extremely susceptible plate to obtain clear pictures.

The moving projectile in the unfortunately only single instance of its impression shows in its picture, in comparison with that of the projectiles at rest, a scarcely noticeable indistinctness at both ends, which arises from the fact that, as has been calculated, the shot during the exposure of the plate to the light moved forward about three centimeters. A staff to be shot away is placed before every projectile in the direction in which it travels, and is distinctly visible in all four pictures, indicating clearly in its different assumed positions, from its breaking and during its fall, that the harmony of the four apparatus was complete and that they acted well.

The proof of the possibility of the experiment has thus been made. It is, in fact, much to be wished that Herr Anschutz should be placed in a position to continue his work much further; we should then receive more exact information in regard to the trajectories of projectiles on many points now shrouded in uncertainty. There is no doubt that this art of instantaneous photography, which is still in its infancy, is destined under skillful hands to undergo large development, which will place the whole science of ballistics upon a more thoroughly secure foundation of experiment and tangible fact than the airy and hypothetical grounds on which it now rests.

Some time ago Professor Mack, of Prague, succeeded in photographing rifle bullets in motion quite distinctly by help of the Topler-Schieren method, which is the result of experiments carried out during many years by Dr. Topler, one of the professors at the Polytechnikum at Dresden, with various lenses, in order to bring under proper examination rays of light under different phases of refraction, and by this means it has been rendered possible to examine the cushion of air which surrounds a projectile flying at a high velocity. These bullets were fired in a darkened room, and in consequence of their small range offered the advantage that a momentarily appearing electric spark could be used as a source of light. With such an arrangement naturally the complicated mechanism for bringing the time of exposure of the plate into agreement with the flight of the projectile becomes quite superfluous, as the open apparatus can only receive the impression during the short moment in which the electric spark conveys the light to it, while simultaneously illuminating the bullet flying past it.

Whether a corresponding arrangement can be made applicable, and an electric spark suffice to illuminate sufficiently artillery projectiles, must reasonably be doubted; fortunately, Herr Anschutz's experiments have shown that as simple a method for photographing large projectiles exists, and that not only distinct impressions of the projectiles in motion can be taken in series, but also simultaneous impressions of one and the same projectile at the most different points of its path, at the moment of its striking and penetrating armor, and in the case of shell at the moment of bursting.

We hear that Herr Anschutz has had the honor of laying before the Kaiser at Muncheburg, on the occasion of the maneuvers, his first successful impression of a projectile in flight. May this be a good omen for the further progress of his efforts, and may also the necessary means not be wanting for the carrying on of his important and costly experiment. H. G.

* Translated from the *Deutsche Heeres-Zeitung* by Commander H. Garbett, R.N.—*Jour. R. U. S. Inst.*

THE WASH-OUT PROCESS FOR PHOTO-ENGRAVING.

By W. T. WILKINSON.

THIS method of producing phototype blocks is very interesting as a process, but is of limited practical use—in fact, nothing can be done by it that cannot be done cheaper, better, and quicker by the etching method; for half-tone blocks it is quite useless, as there is no power of compensating for the degradation of the whites caused by the screen that there is in stopping out and rebiting in the etching method.

In the swelled gelatine process it is necessary to use a gelatine of the very best quality, so that the unexposed portion of the film may absorb the maximum quantity of water, and so enhance the height of the relief; but in the wash-out process we require to use a very poor quality of gelatine, so that the setting power be easily destroyed by prolonged boiling with ammonia and sodium carbonate or hydrochloric acid.

The process is as follows: Three pounds of glue are soaked in cold water until thoroughly soft, the water being changed at frequent intervals so as to remove any soluble impurities. When quite soft, drain free from water, and place in a jar; place this in a pan of cold water, and put on a slow fire, gradually raising the temperature to 200 deg. F. When the glue is melted, add five ounces of ammonia, or one ounce of hydrochloric acid, then keep up the temperature of 200 deg. for three days or a week until the setting power of the glue is quite destroyed. When this stage has been reached, add five ounces of molasses, ten ounces of water, three ounces of bichromate of potassium in fine powder, mix thoroughly, then strain through muslin, when it will be ready to coat the plates previously prepared as below.

Clean glass plates of a suitable size with dilute nitric acid, rubbing and washing well, then coat with

Gelatine	2 ounces.
Water	20 "
Bichromate of potassium	30 grains.

—melted and flooded over the wet plate; when coated, stand up to dry on a rack, and when dry expose for an hour or two to strong light, so as to make the thin film of gelatine thoroughly insoluble.

Now place these plates on the leveling screws of a drying box, which can be heated to 80 deg. or 90 deg. F., then coat with the sensitive glue mixture, putting on as much as is possible without overflowing, and when all in the box are coated, close the lid, and the films will be dry in from three to six hours. Be very careful of dust and air bells, as they would quite spoil the surface.

When the plates are dry, expose under the negative, which must be quite opaque in the black portions, representing the whites of the original, and clear in the lines; the progress of the exposure can be seen from the back, but with practice a time exposure can be judged, from five to thirty minutes in sunlight being required, the time being longer the deeper the relief.

When the exposure is complete, lay the plate in a dish of cold water for ten minutes, then put into an upright bath containing water at 100 deg. F., when the development will be complete in from two to six hours; then remove, wash under the tap, and immerse for fifteen minutes in a strong solution of alum, wash, remove the surplus water by dabbing with a damp, soft rag, and at once pour over it plaster of Paris, using the very best, and not at all thick; allow the plaster a couple of hours to set, then lift away the plate carrying the gelatine image; after the plaster is poured, the back should be smoothed as much as possible.

From this plaster cast a wax mould is taken which, after having the whites made higher by running wax upon them from a hot conical tool, is polished with plumbago, when it is ready for the electrotyper.

The electrotype may be made from the gelatine direct if the subject is a close one and there be no whites to build up, in which case, after washing from the alum bath, it is soaked in spirits of wine for half an hour, and put away to dry. When dry it is sprinkled with fine blacklead, and polished with a soft brush, when it is ready for the electrotyper.

In cases in which extra depth is required, the washing out may be effected with saturated solutions of bichromate of potash or soda, or resinate of magnesia, sulphate or chloride of magnesia, and of hypochlorite of lime.

The sensitive plates will keep in a chloride of calcium box for about a month, but after that I find they are difficult to develop. If the first coating put on does not give sufficient relief, a second coating may be given.

I may say that I find the gelatine substratum given above very useful for the plates or the film for the swelled gelatine, there being no danger of frilling off when soaking after exposure, as there sometimes is when plain glass is used.—*Wilson's Photographic Magazine.*

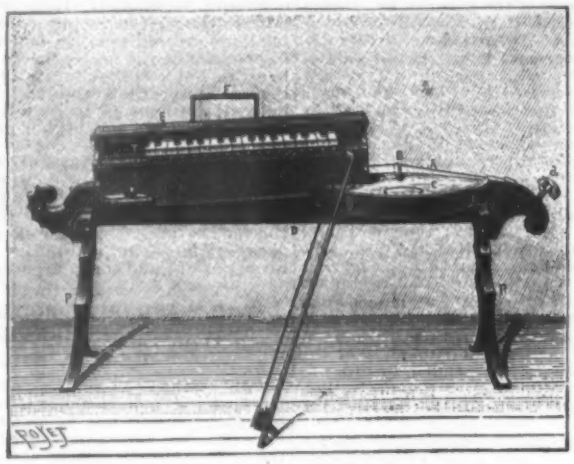
THE MONOCHORD.

PYTHAGORAS is accredited with being the originator of this instrument, the monochord, which twenty-five centuries ago was the first type of musical instrument, has developed into the clavichord, the spinet, the harpsichord, and finally the piano. It appeared to have been entirely forgotten until it was brought into notice again by an amateur, who reconstructed and improved it. The device is very simple, and is the invention of Mr. J. Poussot, who constructs it by simply stretching a brass wire over a thin convex board semicircular in shape. This board, which serves as a sounding board, is mounted on two supports. The string bears on the bridge and is tightened by a binding pin, and is set in vibration by the ordinary violin bow.

In order to reproduce the exact notes, a narrow flexible strip of wood is placed under the cord, upon which are marked by means of raised frets the various notes. By pressing with the thumb on the proper fret and using the bow, the desired note is produced. This is the monochord "reinvented." Encouraged with this success, the inventor proceeded to improve it. The convex board was abandoned and replaced by a resonator, which had been built by a well known lute maker of Mirecourt, this being mounted upon two handsomely ornamented legs. An excellent tone was produced by the use of a cord composed of a number of very fine wires bound and twisted together. The cord rested upon an ordinary violin bridge. But the monochord in this shape proved to be hardly satisfactory.

For the past two years (since its production) this has been simply the property of an amateur artist, who has had no idea of putting it on the market, but it has had so many admirers, and there has been such a demand for it, that Mr. Poussot has decided to patent and develop his invention. A critic who examined it reported it to be no more difficult to master than the violin. The fingering had to be simplified, and a key board was substituted for the sliding stop.

The monochord as it is now put upon the market is as follows (Fig. 2): As in the "artist's monochord," the string, A, rests on a bridge, B, which produces the tone in the resonator, C. This is mounted upon a frame, D, resting on two supports, P. A binding pin is placed at one end of the instrument to produce the proper tension in the string. The feet, P, are made to fold under the box. A key board, E, is mounted on the stand. The string passes between the stops or keys, T, and a wooden blade or bar, where it is firmly held as between two jaws. The string thus held will produce the note corresponding to that key. There is a cover for the key board, also a music rest. The keys of the key board are both equal and unequal in dimensions.



THE MONOCHORD.

The system of having equal keys is much more convenient and attractive in appearance, but it is more expensive, owing to the difficulty in preserving the same space for all the notes. The keys of unequal dimensions render the fingering somewhat irregular, but that is not a serious obstacle, the difficulty being soon overcome.

The monochord has a rather penetrating tone that is admirably adapted to the human voice. When used alone, it is found of great service to professors of music in relieving them from great strain and fatigue. It is well adapted for parlor use. A capital orchestra can be formed by having a number of instruments from the bass to soprano, including the alto, the baritone, etc., and playing them in concert. These instruments give a very good effect from a reading desk or lectern.

A CONCERT OF MONOCHORD CONDUCTED BY YOUNG GIRLS AT THE VILLAGE OF PIERRE, FRANCE.

As the flexible wooden blade only allowed one tone to be played, a cylinder having twelve faces was used instead. The scales were marked on each face of the cylinder, thus: *Do, sol, re, la, mi, si, fa, si b, mi b, la b, re b, sol b.* When it is desired to play in *mi*, the cylinder is turned until *mi* is in position. A sliding stop is held in the left hand for pressing on the cord for producing the desired note. The vibration is produced by the bow as before, and the desired note is obtained by pressing on the proper division on the cylinder. This is the "artist's monochord."

Any piece can be played by this system, and it produces a considerable range of scale and a very expressive tremulo. It might be mistaken for the human voice if heard without being seen.

When we visited the inventor in the village of Pierre, near Toul (Meurthe-et-Moselle), we had the pleasure of hearing an orchestra of six peasant girls (Fig. 1). The facility displayed by these children of twelve or fifteen years of age in rendering a symphony of Mozart and a concerto of Beethoven, the accuracy, the delicacy of tone, and the general effect of the orchestration, so far delighted us that we decided to give an account of it to the readers of this paper.—*A. Bergeret in La Nature.*

THIRTY-SEVEN millions of passengers is the reported number that crossed the great suspension bridge between New York and Brooklyn for the year ending December 1, 1889.

CANNING FRUIT.

THE Pomona *Times* publishes the following detailed statement:

"A word or two as to the philosophy or science of canning will not be amiss, for it is founded on scientific principles, and there may be many modifications in the methods of securing the results desired, so that methods may, in many instances, be modified by circumstances.

"There may be said to be two causes for the fermentation and decay of fresh fruit. Everywhere in the atmosphere there are little floating germs which attach themselves to cut fruit, causing fermentation. The oxygen of the air is also ready to enter into combination and produce decay. The first of these causes the strongest influences in starting the processes of decay.

"Canning checks the process from the fact that a boiling heat kills all the germs of ferment, and by closely sealing, no more can enter, nor can the oxygen of the air gain access to the fruit to act upon it.

"It has been found that the germs will not go through a sheet of cotton batting, and fruit has been preserved by closing it pretty tight, to prevent evaporation, and wrapping the joint loosely with cotton.

"Fruits are in a proper condition to can when they are fully ripe, but not soft and mushy. They can be canned at any time before they are too ripe, but at the expense of a fine appearance. Many of our canneries sacrifice quality in taste and flavor to quality in appearance. The home canner will seek the best flavor and make the fruit look as well as he can.

"Glass is of course best, but tin cans will keep fruit just as well, with a slight danger of the acid of the fruit dissolving a portion of the tin.

"If no regard is had for fine appearance, the easiest way to can is to cook the fruit in a porcelain or granite ware kettle, in small quantities, two or five cans at a time, and when cooked pour into cans and seal at once.

"If the finest appearance is desired, all fruit that is peeled or cut should be at once dropped into water to keep it from discoloring. By the aid of a silver spoon or knife the pieces can be arranged in the can systematically and regularly, and the can should then be shaken down as solid as possible by gently jolting on the table. It should be filled with sirup. We leave the amount of sugar in this sirup to the taste of each man. We prefer for most fruits a good strong sirup, but all do not. The filled cans should now be placed in a boiler with water enough to come up nearly to the neck and covers put loosely on, and the whole brought to boil and kept long enough to cook thoroughly. The time varies. The following table is said to be a good guide:

Fruit.	Time for boiling.	Sugar to qt. of fruit.
Cherries	5 min.	6 oz.
Raspberries	6 "	4 "
Blackberries	6 "	4 "
Strawberries	8 "	8 "
Plums	10 "	10 "
Wortleberries	5 "	8 "
Pie plant	10 "	8 "
Sour pears (whole)	30 "	4 "
Bartlett pears (halves)	20 "	6 "
Peaches (halves)	8 "	4 "
Peaches (whole)	15 "	4 "
Pineapples (sliced)	15 "	6 "
Crab apples	25 "	8 "
Sour apples	10 "	5 "
Ripe currants	6 "	8 "
Gooseberries	8 "	8 "
Wild grapes	10 "	8 "
Quinces (sliced)	15 "	10 "
Tomatoes	20 "	½ teaspoonful of salt.

"The fruit will shrink considerably in cooking, and a few pieces should be cooked in a separate dish to fill up with if there is a chance. If this extra dish is cooked with a little more sugar than the rest, it is a good idea. As soon as the cans are cooked enough, remove them from the water, take off the covers and fill the cans as full as possible, the top with boiling hot sirup; wipe the top and neck clean, put on the rubbers, and screw down the tops as tight as possible. Watch the rubbers carefully to see that the tops fit to them well.

"It is sometimes necessary to test the zinc covers of the Mason jar, by placing them on a smooth, flat surface, and if the edge does not come down close all the way round, it can be pressed down by rubbing it with a smooth iron.

"Set the fruit away where you can watch it for a week, and if you discover no fermentation, it can be put in a dark place to keep. Move it as little as possible after this. If you have any doubts about any can being perfectly sealed, you can wrap the top in cotton and it will be apt to keep as well as any. Apricots, peaches, nectarines, and pears should be as ripe as possible and still keep their shape.

"If you fill cans with hot cooked fruit, they will not break if you stand them on a wet folded cloth while filling.

"Jellies are delicious, and can be made of most kinds of fruit. Currants are very nice, and a few raspberries with them gives the whole a raspberry flavor. Blackberries, apricots, plums, apples, quinces, and grapes before they are fully ripe make excellent jelly. Some small egg plums and some Verdel grapes gave us some fine jelly, very light in color, and tart. Cook the fruit in a little water, and the juice which will drain out without pressure is nicest. By straining twice through a flannel bag, the juice that comes from pressure is made about as clear and nice as any.

"Quinces may be pressed gently for a portion of their juice, and the pulp mashed and rubbed through a sieve or one of those crushers made on purpose, and with the addition of sugar made into a nice marmalade. Jellies will be lighter colored to boil the juice alone before adding the sugar. You will need about equal bulks of juice and dry sugar to make good jelly glasses. The best cover we have ever found is melted paraffine. The glasses should be allowed to be open, or lightly covered for a day or two to shrink; then pour the melted paraffine on top and let it cool. The hot paraffine kills all germs of mould or ferment and keeps it air tight. The name of the jelly may be written on the smooth surface of the paraffine when cold. It will come off as neatly as a glass cover. If you do not use paraffine, cover the top with a wax paper neatly cut to circular form the

exact size of the glass and pressed down to the jelly. Then put on the regular cover.

CRYSTALLIZED FRUIT.

"This can be made at home very nicely. Select nice, firm fruit. Cook it a little in clear water, the amount of cooking you will soon learn. Place the cooked fruit into very thick, hot sirup, and let it stand for about two days; then drain off the sirup, which will now be very thin, and boil it down until it is thick again, put in the fruit and let it heat through and stand for about four days, then repeat the process, letting it stand longer every time. When the sirup no longer gets thin, remove the fruit and dry it in the sun or in an evaporator with gentle heat. It may be rolled in granulated sugar to fully dry it, and then may be packed in boxes for use. By using the first sirup for jelly, and making up some entirely new, the process can be hastened and the fruit will dry better, but will not be of quite so good a flavor. Try it. It will cost you fifty cents a pound to buy such fruit confections, and they are nice for dessert when such confections are required."

THE MANUFACTURE OF ALUMINUM FROM CRYOLITE.

WE give three engravings illustrating the manufacture of aluminum from cryolite at the works of the Alliance Aluminum Company, at Wallsend, near Newcastle-on-Tyne. The works have been erected under the direction of Dr. Netto, to whom the method for obtaining aluminum from cryolite by the direct action of sodium without the use of chlorine is due. Our illustration (Fig. 1) represents a battery of furnaces employed for the preparation of the sodium required in the process. They are built in continuous blocks, each furnace occupying a space 8 ft. ×8 ft. ×6 ft. high. In the center of each furnace is fixed a cast iron retort 3 ft. high and 2 ft. wide at its broadest part, with a spout projecting from its base, through which the liquid slags are drawn as the retort fills. The retort is covered by a cylindrical box luted on gas tight with slaked lime, and containing orifices through which the mixture to be treated is fed into the retort. It is also fitted with a tube, to which is attached the sodium condenser. After heating the retort a charge of gas carbon is introduced and brought to a bright red heat, and then molten caustic soda (previously melted in a cast iron vessel by means of the waste heat of the furnace) is allowed to slowly run through a siphon on to the surface of the hot carbon. In a few minutes thick clouds of vapors issue from the retort, which readily kindle and burn with an intense yellow flame at the mouth of the condenser. The flow of caustic soda is regulated by the workmen, who judge of the progress of the reaction from the intensity and volume of these flames. The metallic sodium drops from the mouth of the condenser into shallow iron trays, from which it is quickly transferred to air tight iron drums for further use. Each retort makes about 60 lb. of sodium per diem, but has to be constantly watched to prevent the condenser from becoming plugged with the condensed sodium, which has therefore to be removed by an iron rod from time to time, and about 1,600 lb. of sodium may be manufactured from one retort before it is necessary to replace it. Our illustration (Fig. 3) represents the interior of the aluminum factory, which at present contains four reverberatory furnaces in two blocks, each block 23 ft. by 8½ ft. by 9 ft. high. Each furnace is charged from the top with a mixture of cryolite and salt, which when quite melted is drawn off into an iron converter mounted on wheels and trunnions, in which the third and final operation is carried out. We illustrate this operation in Fig. 2, in which is shown the method employed for introducing the sodium into the molten cryolite. Two men, as soon as the sodium is thrown into the fused mass, plunge into it an iron dipper, which is moved up and down until all action ceases. After this dipping process, the bulk of the slags are poured off into a large iron pot, while the aluminum is found in the shape of a button at the bottom of the converter. The yield of metal amounts to about 8 per cent. of the weight of cryolite, and four parts by weight of sodium are required to furnish one part of aluminum.

For special classes of aluminum the operation is carried on in crucibles, since in this way a better control of the liquid mass of cryolite and flux is obtained, as the crucible stands in the furnace during the whole operation of dipping. The crucibles are made of fireclay, and when heated the sodium is introduced by fastening a block of the metal on to an iron rod and covering it with a circular piece of metal provided with holes, and also a slit, into which the rod slides. The circular piece of metal is attached to a rod of iron, which thus acts as a cover to the sodium. By repeating the sodium dipping a better grade of metal is obtainable. Four qualities of metal are now being made by this process, varying from 90 to 99 per cent. of aluminum.

A small percentage of aluminum is found distributed through the slag, from which it is recovered in the form of aluminum bronze, by fusion with copper in a reverberatory furnace.

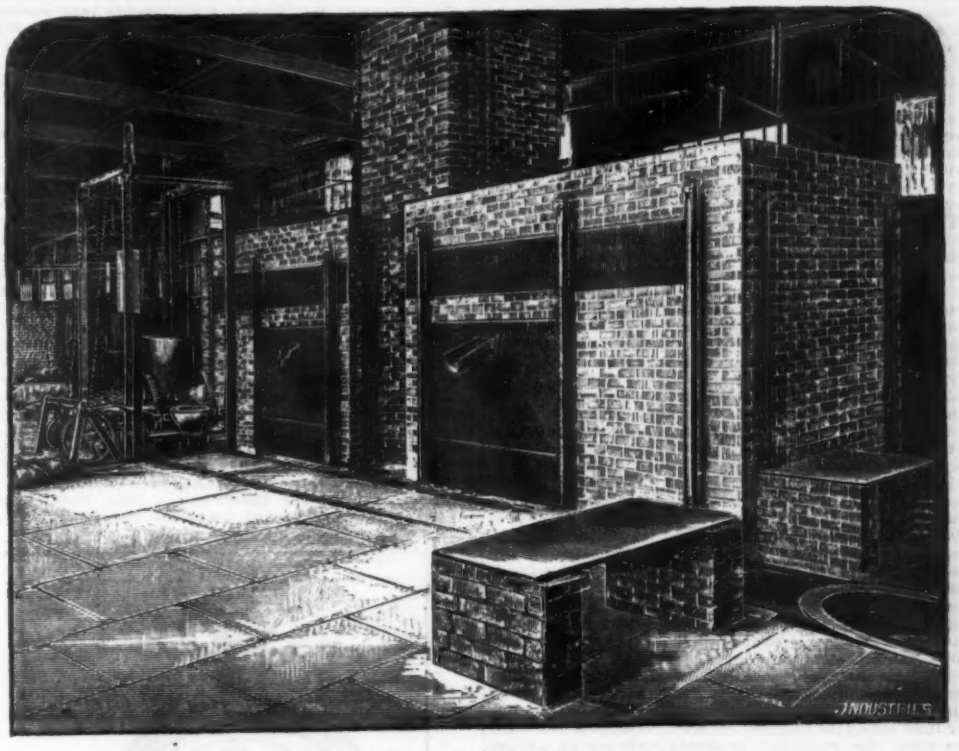


FIG. 3.—INTERIOR OF THE ALUMINUM FACTORY.

VULCANIZATION OF RUBBER.

By RICHARD GERNER, M.E.

BEFORE we inquire into the meaning and the process of *vulcanization*, let us ascertain why India rubber, for the purposes of its application in the industrial arts, needs to be *vulcanized* at all. In general, ordinary India rubber retains its most characteristically useful properties through a very limited range of temperature, as a very moderate degree of cold on the one hand or of heat on the other suffices to render it valueless, as regards the major part of its industrial uses. At the freezing point it is rigid and hard, in fact frozen. At the boiling point it becomes so soft as to be valueless as an elastic material. The consequence is that India rubber in its natural condition has a very limited applicability.

Indeed, the meaning of this is that if we knew no method of treating or *curing* the gum, so that it will retain its good qualities under the influences of heat and cold, the manufacture of India rubber would not be one of the great industries. But happily we do know of such methods, thanks to Charles Goodyear and others. Before any of these methods were known the manufacture of India rubber had been carried on either by direct mechanical treatment of the gum after simple cleaning or by the action of some volatile solvent.

It seemed at the time as if the gum was likely to fall into disuse, or that its applications would have to be circumscribed on account of its physical defects. Besides the principal ones already mentioned, are these, that contact with grease, fat, or oil was hurtful, that it was too adhesive and sticky to be practicable in many of its desired applications, that continued use and tension soon impaired its elasticity, and that it imparted an unpleasant odor to the goods. At the most critical period of the history of India rubber, the method or process *of curing* the gum so that it would have a perfect elasticity and an unimpairment of its most valuable qualities under all reasonable temperatures, and under contact with the deteriorating agents alluded to, was invented. This is the renowned process of *vulcanization*, which has saved India rubber from being an unimportant element in the industrial arts, and which has raised it to the dignity of an indispensable article.

Sulphur, which is used both in a pure state and in its combinations, will be considered only in connection with its employment in the rubber industry. Pure sulphur occurs in the market in two forms, as *flowers of sulphur* or as pulverized roll, bar, or stick sulphur. Both are employed in the industry. The first qualification is that the sulphur should be chemically pure, free from all trace of acid, and also from the moisture which acidulated sulphur tends to absorb from the atmosphere. Ordinary flowers of sulphur are prepared by passing sulphur vapor into large chambers constructed of masonry, so that this vapor shall condense into minute crystals resembling snow. They are almost invariably acid in their reaction. This acid may be removed by washing with an abundant supply of water and then drying it at a gentle heat. All samples of sulphur ought to be tested with litmus paper before be-

FIG. 1.—FURNACES FOR THE MANUFACTURE OF SODIUM.

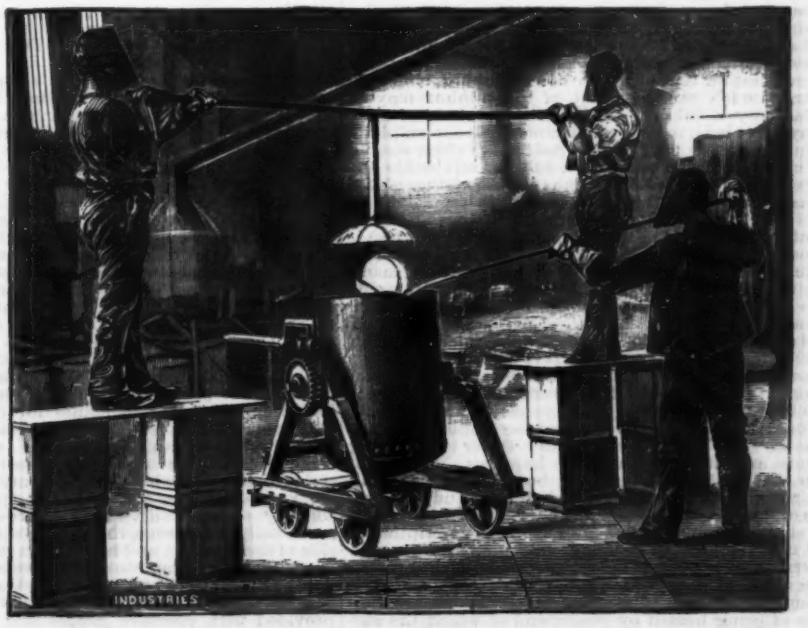


FIG. 2.—INTRODUCING SODIUM INTO MOLTEN CRYOLITE.

THE MANUFACTURE OF ALUMINUM FROM CRYOLITE.

ing employed in the manufacture. If blue litmus paper turns red, the presence of acid is thus indicated. The so-called *milk of sulphur*, or precipitated sulphur, is, on account of its very fine state of division, especially adapted for admixture with India rubber, but it is too expensive, and liable to be damp. Flowers of sulphur are also more expensive than pulverized bar, roll, or stick sulphur, and therefore the latter is more commonly employed.

The manufacture of pulverized sulphur is now a separate and extensive industry, as enormous quantities are used by rubber manufacturers and others. Henry Gerner recommends every large consumer to prepare it himself. Sulphur melts at 239° Fahr., of the significance of which more anon. Of the sulphur salts, or sulphur in its combination, sulphide of antimony is the most frequently used. For rubber manufacture it is prepared by boiling the native sulphide in a solution of caustic soda, and precipitating the solution thus obtained with a slight excess of hydrochloric (muriatic) acid. This, when washed and dried, is ready for mixing with the India rubber. It contains a percentage of free sulphur, which, as we shall see, is indispensable. The sulphides of lead, mercury, and zinc, the polysulphides of the alkalies and of the alkaline earths, and the hyposulphites, as of lead and zinc, are also frequently employed.

The remarkable changes effected in the India rubber by the introduction of sulphur into the same was pointed out by a German chemist, Luedersdorf, of Berlin, in a work published as early as 1832, but it is doubtful whether Goodyear ever saw this work. The fact remains that the industry must thank the latter for the introduction of the process of *vulcanization*. If we take a strip of India rubber and immerse it for a few minutes in a bath of molten sulphur, of a temperature, say, of 250° Fahr., the gum absorbs the liquid sulphur and turns light yellow, according to the length of the time it is permitted to remain in the bath; it absorbs from 10 to 50 per cent. This is merely a dissemination of the pure sulphur throughout the pores of the gum, and the characteristics of the latter remain unchanged. It is still subject to the stiffening influence of cold, and dissolves in the ordinary solvents. But when further heat is applied to the sulphureted gum, or if it is permitted to remain long enough in the sulphur bath, a change takes place. What the precise nature of the change is appears to be not very well understood, neither by the manufacturers nor by the writers on the subject, let alone by the public at large. What happens is that from 1½ to 3 per cent. of the sulphur enters into *chemical* combination with the India rubber, and no more. The bulk of the sulphur is only mechanically held in suspension, but in an amorphous state, in the gum. Any percentage of sulphur that is incorporated with India rubber enters under heat into this physico-chemical combination with the gum, the resultant products varying in nature with the percentage of sulphur introduced.

After the introduction of the sulphur, and before the application of heat, the compound is called simply *mixed rubber*. The application of heat *cures* or *vulcanizes* the India rubber. The product is called *vulcanized rubber*. In practice, the India rubber and the sulphur are usually mixed together mechanically by suitable machinery, and the curing process takes place in a boiler or vessel called a *vulcanizer*, or in a steam press. Sulphur has a threefold action on India rubber, according to the percentage introduced. If the percentage is a small one, say 5 per cent., and the mixture is vulcanized, the result is a soft, gray, elastic body, which is the common *vulcanized rubber*. If the percentage of sulphur is a medium one, say 25 per cent., the result is a semi-hard body, of the consistency of leather, which also has its uses in the industrial arts. If the percentage of sulphur is a great one, say 50 per cent., the result is a hard, black, pliable body, which is *vulcanite* or *ebonite*. In the sequel, soft vulcanized India rubber will be called simply *vulcanized rubber*, and the hard vulcanized India rubber by the name of *vulcanite*. Some Germans apply the latter name to the soft product.

All excess of sulphur in vulcanized rubber beyond that actually required is said to be undesirable, but it is unavoidable, as a greater percentage than that stated cannot by any means be made to combine chemically with the gum, and yet the presence of this percentage alone is not sufficient to vulcanize. A part of the excess may be washed out by boiling in a dilute solution of caustic soda, or of sulphite of soda, but it injures the product, and leaves it cellular. This is called *sulphurized rubber*. It will be understood that it requires the presence of *pure* sulphur to properly vulcanize India rubber, but for the purposes of the rubber manufacturer, as much as 75 per cent. of the sulphur may be replaced by a sulphur salt, such as sulphide of antimony, or of lead, mercury, and zinc. It is the sulphide of antimony that produces the *red rubber* often seen in the market. The presence of a sulphur salt beside the pure sulphur is supposed to enhance the virtues of the vulcanized product, but this is at best doubtful. A solution of the mixed polysulphides of lime, at a temperature of about 275° Fahr., being Gerard's process, vulcanizes thin sheets of the gum by exposure to it. Thin sheets may also be embedded in sulphur and made to absorb about 10 per cent. of it, and then vulcanized. Exposure to sunlight has a certain vulcanizing action on mixed rubber. In the Parkes cold process the gum is placed in a mixture of one part of chloride of sulphur to 40 of bisulphide of carbon. It is vulcanized in a few minutes. When the gum is kneaded with a certain amount of *dry* chloride of sulphur for a few minutes, it also becomes vulcanized. The process does not apply to bulky goods, as the vulcanizing action does not penetrate far below the surface. Other vulcanizing agents are nitric acid and the halogens. A piece of thin sheet rubber dipped into bromine becomes vulcanized almost instantly. We shall now study the process of manufacture of India rubber.

I shall confine myself at present to the description of the manufacture of common vulcanized rubber, and reserve hard rubber or vulcanite for a special occasion. The cleansed raw India rubber, as already stated, is taken on to a pair of *mixing rollers*, which are capable of being heated by steam, and of which the surfaces are quite smooth. They are rotated at unequal speeds, three to one being a common difference between their rates, and one of them is heated to a higher degree than the other, the purpose of which is to cause the material to adhere to the slower-going and hotter roller nearest the operator. By means of set screws the rollers can be placed nearer to or farther from each other. A charge, technically called a *batch*, or about 30 lb. of India rubber, is run through the rollers until it is quite soft and homogeneous. When the gum is in this condition, powdered sulphur is sprinkled upon it from above, and this sprinkling on of the sulphur and the working are continued until all the material is thoroughly incorporated. The quantity of sulphur varies with the required nature of the product; in ordinary cases the proportion is from 5 to 10 per cent. of sulphur. This breaking down of the rubber, and the incorporation of the sulphur, takes at least an hour. The temperature required to reduce the India rubber is a very high one, being about 280° Fahr., which tends to further convert its fibrous constituents into viscous ones. The high temperature is, however, unavoidable. When the mixed rubber is ready, it is in a state to be employed directly for various manufacturing purposes, unless it be required to incorporate with the same certain admixtures by way of adulteration, to cheapen the product, and, it is needless to add, to degenerate its quantity. It is the common practice to mix metallic salts and mineral earths with the India rubber during the incorporation of the sulphur, and it sometimes happens that the amount of adulteration is enormous, upward of *five hundred* per cent. in extreme instances. The presence of any large proportion of inert matter naturally detracts considerably from the elasticity of the gum, and as most rubber goods are sold by weight, it is just as well for consumers to know that the bulk of the rubber goods purchased is not pure gum, but lead and zinc salts. The powders most extensively employed for thus lowering the quality of the rubber are the following: Clay, chalk, or whiting, French chalk or talc, sulphate of baryta, plaster of Paris, oxide of zinc, sulphide of zinc, sulphate of lead, various oxides of lead, oxycarbonate of lead or white lead, magnesia, silica, fuller's earth, ground scraps of old rubber, lamp black, and a great many other salts and earths. It depends upon the use to which the product is to be put whether the mixed rubber can be adulterated at all, or what the degree of adulteration shall be. When the batch comes from the mixing rollers, it is either stored away for future use, after having been sprinkled with sulphur, like dough with flour, or it is at once utilized. In the former case it must be *warmed up* again immediately before use, either on a pair of special *warming-up rollers* or on the aforesaid mixing rollers. Let us presume that the mixed rubber is to be made into sheets, as that is usually the most important feature of rubber manufacturing, all other phases of the industry being more or less specialties. For this purpose it is taken to a large rolling machine, being a heavy framework bearing from three to four smooth rollers, also capable of being heated by steam. This is called a *calender* (or *calender* or *calander*).

The rollers are heated up to a temperature which varies with the degree of adulteration of the mixed rubber; the greater the adulteration, the lower the temperature. The mixed rubber must have the corresponding temperature before its introduction between the rollers. In the case of the calender consisting of three rollers, the mixed rubber is first passed between the top and the middle one, adhering to the latter, and then through the middle and bottom one. It then passes around and under the latter, and thence usually on to an axle, where it is wound up together with a layer of cloth, or well sprinkled with soapstone, to prevent the surfaces from adhering to each other. In other instances it passes from under the bottom roller of the calender on to and over small rollers, or a drum, thence to an endless belt, and it may be at the end hereof either wound up on an axle or it may be cut and transferred to frames. In all other cases the mixed rubber, instead of being taken to the calender, is brought to other machines for diverse purposes. The rubber is now ready to be vulcanized.

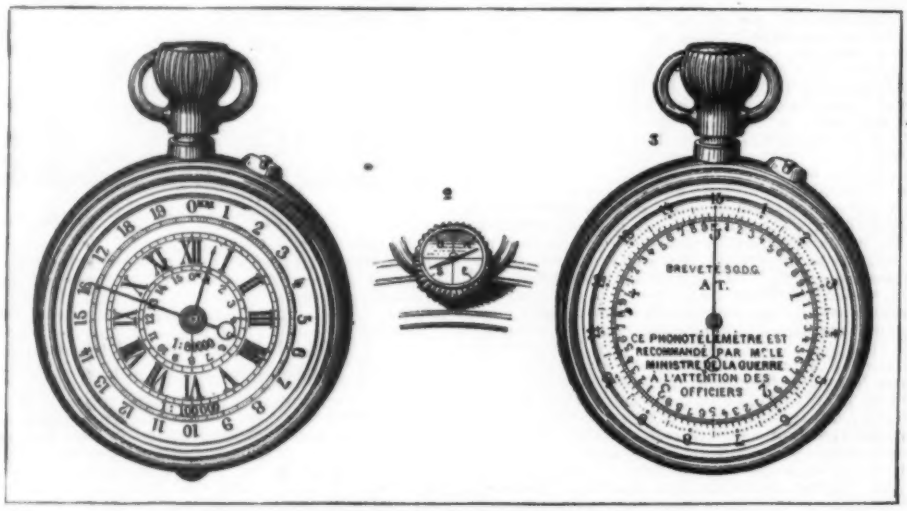
Rubber is vulcanized either in vulcanizers or in steam presses. Vulcanizers are vessels provided with a steam-tight cover which can be securely clamped down. They are of all sizes and shapes, and placed either horizontally or vertically. In the former instance they are usually very large, the cover being hinged to one side of the opening, and have tracks running into them, on which are cars containing the goods to be vulcanized. All the vulcanizers and steam presses are in communication with the steam supply pipes of the works, and are provided with pressure gauges and thermometers in order that those in charge may be enabled to regulate the inflow of steam and the temperature within. The *vulcanizing medium*, that is, the medium in which the goods are placed when run into the vulcanizer, may be gaseous, liquid, or solid, according to various requirements. Air may be the medium, or it may be water, or it may be soapstone. The goods being placed in the vulcanizer and the cover clamped down, "live" steam is turned in and left on for a length of time varying with the requirements of the product, whether it be light or heavy, thick or thin, almost pure or heavily adulterated. The time varies from half an hour to several hours. The temperature required for vulcanization also varies with the nature of the product, being from 260° Fahr. to 300° Fahr. The latter temperature is about as much as it can stand. When the rubber is adjudged to be properly vulcanized, the steam is *blown off*, the cover unclamped, and the goods taken out. They are then cleaned and packed, unless they require some special treatment, such as polish or deodorization, and are ready for the market. Other methods of vulcanization have already been indicated. With reference to statements in patent specifications, by inventors of improvements in the industry, relative to the time and heat of vulcanization, even the patent expert is puzzled to understand why these times and temperatures cannot be stated within reasonably narrow limits; but it is evident that these differ with every shade of difference in the mixture, the thickness, and the required nature of the goods.—*India Rubber Trades Journal*.

THE PHONOTELEMETER.

THE experience of schools for artillery practice has demonstrated the utility of having, upon opening fire, as accurate a knowledge as possible of the real distance of the mark. The different means hitherto employed for estimating distances all possess more or less serious inconveniences.

Telemeters, which are based upon geometrical methods, are in most cases unwieldy, and always require trained operators; their management requires a certain amount of time, and the results that they furnish may be vitiated by numerous accidental errors due to various causes. In order to use them, it is indispensable to see distinctly the point whose distance it is desired to find.

Measurements by sight require much practice, and the operators most experienced in this exercise run



THOUVENIN'S PHONOTELEMETER.

1. Watch and curvimeter. 2. Compass. 3. Telemeter counter on the back of the watch.

the risk of often being deceived by plays of light, especially at great distances.

Instruments for estimating distances, based upon the velocity of sound, possess, as a general thing, the advantage of being easily manipulated, of demanding no previous apprenticeship, and, for observations, of requiring neither putting in station nor display of *personnel* capable of attracting the enemy's attention. Such are the qualities possessed by the small instrument that Captain Thouvenin, assistant to the director of artillery at Vincennes, has just had constructed, and which he calls a phonotelemeter.

The apparatus consists of a watch with a curvimeter on the face (Fig. 1), of a compass on the stem (Fig. 2), and of a telemeter counter on the back of the watch (Fig. 3).

We have nothing to say relative to the utility and use of the watch and the compass, but we shall give a few details as to the curvimeter, and especially as to the counter—the essential part of the new apparatus.

The Curvimeter.—The face of the watch is provided with two graduations, the first and external one of which corresponds to a map to the scale of 1-100,000, and the second and inner one to the staff office map to the scale of 1-80,000. To use it, the hand is put at zero by revolving the wheel, and, with the latter, the line whose distance is required is followed, and then the graduation of the dial that corresponds to the scale of the map to be measured is read.

The Telemeter Counter.—The telemeter counter is placed on the back of the watch (Fig. 3). The works of the latter move a hand over a dial divided into 15 seconds, and each of the latter is divided into ten equal parts, as are the durations of the travel of projectiles on fuses and on the bridges of cannons. The distances are inscribed upon the dial of the telemeter in the following manner: The kilometers are represented by the large black figures 1, 2, 3, 4, 5; hektometers by small red figures; the 50 meters by black divisions upon the circle; and the 25 meters by red divisions between the black ones.

To use the instrument, it is first wound up. To this effect, it suffices to wind up the watch and to fasten it by means of a snap hook to one of the sides of the field glass. At the moment the flash of a gun, cannon, or lightning is observed, the hand is set in motion by giving the winding stem a quick, slight pressure. The same action arrests the hand at the instant at which the noise of the detonation is heard, and the same action brings the hand back to the zero point.

It then suffices to make a reading upon the graduation of the instrument in order to obtain the distance, at least within about 25 meters. If the half divisions be estimated, an approximation of from 10 to 12 meters will be obtained.

This instrument will permit, before battle, of measuring the distances to the important points of the territory. To this effect, it will suffice to send horsemen to such points in order to burn a few cartridges there. Should the appearance of these horsemen happen to draw a few shots at them from the enemy, that would give an additional means of having, approximately, the distance of the adverse position.

The first shots fired by the enemy will permit estimates of distances, placed upon elevated points, such as trees, houses, belfries, etc., and even on horseback and during night, to register the different distances and to communicate them to the proper authority, when the combatants come upon the field.

The Thouvenin phonotelemeter costs scarcely any more than an ordinary seconds watch, while at the same time it permits of estimating tenths of seconds.

This instrument is capable of rendering services not only to the officers of different armies, but also to physicians, engineers, and tourists, and to all those who have an interest in estimating times and distances with accuracy.—*La Nature.*

SIMPLE WAY TO MAKE POROUS WATER-PROOF CLOTH.

A POROUS waterproof cloth is the best for outer garments during wet weather for those whose duties or labor causes them to perspire freely. The best way for preparing such cloth is by the process adopted for the tunics of the French soldiers during the Crimean war. It is as follows: Take 2½ lb. of alum and dissolve in ten gallons of boiling water; then in a separate vessel dissolve the same quantity of sugar of lead in ten gallons of water, and mix the two solutions. The cloth is now well handled in this liquid, until every part of it is penetrated, then it is squeezed, and dried in the air or in a warm apartment, then washed in cold water and dried again, when it is fit for use. If necessary the cloth may be dipped in the liquid and dried twice before being washed. The liquor appears curdled when the alum and lead solutions are mixed together. This is the result of double decomposition, the sulphate of lead, which is an insoluble salt, being formed. The sulphate of lead is taken up in the pores of the cloth, and is unaffected by rains or moisture, and yet it does not render the cloth airtight. Such cloth is also partly uninflammable. A solution of alum itself will render cloth prepared as described partially waterproof, but it is not so good as the sulphate of lead. Such cloth—cotton or woolen—sheds rain like the feathers on the back of a duck. As to the cost, alum is 1½d. per pound and sugar of lead 8d. per pound, and doubtless each could be had for less in quantities. Experience will tell the amount of liquor necessary for say a score of capes; but, any way, the process will be found to be sufficiently inexpensive and effectual.—*London Field.*

THE WATER BAROMETER OF ST. JAMES' TOWER.

THE first idea of constructing barometers of a large size dates back to Blaise Pascal. It will be remembered that this celebrated physicist, having learned through Father Mersenne of Torricelli's experiments, repeated them at Rouen (where he was then living), first with a tube of mercury, and then with tubes of different diameters and lengths that he filled with various liquids. The principal of the barometers was the one that he mounted in 1646 in the yard of a glass works of the Faubourg St. Sever at Rouen. The tube of this was forty-six feet in length and was full of water mixed with wine.

The difficulties in the way of constructing these instruments were such that the use of them was abandoned. And, since that epoch, the attempts to construct large barometers have been few. Nevertheless, we must mention the water barometer that Professor Daniell mounted in 1830 for the Royal Society of London, and the one mounted in 1870 at Kew Observatory by Mr. Jordan. This latter had a cistern, and the water was replaced with glycerine, the greater density of which necessitated less height; in fact, the gravity of glycerine being taken at 1·26, gave a minimum of 27 feet for the Kew barometer. Finally, in 1886, Mr. Zophar Mills, a New York merchant, had a glycerine barometer mounted at his house.

Among all the liquids adapted for making barometers, water has appeared to us to be one of the most practical, principally on account of the greater facility with which it fills the tube.

On the contrary, this liquid has the fault of vaporizing at the ordinary temperature. The aqueous vapor which then forms in the barometric chamber acts upon the level of the liquid, and, for a same pressure, maintains it so much the lower in proportion as the temperature is higher. In order to remedy this inconvenience, we have, in the barometer that we have just installed in the laboratory of physical studies of St. James' Tower, covered the surface of the water with a stratum of a special oil, which prevents evaporation.

This oil gives rise to the formation of concave or convex meniscuses, according as the barometer rises or falls, and this permits of ascertaining the motion of the barometric pressure at a glance.

In the Kew barometer, Mr. Jordan preserves the glycerine from contact with the air by means of a thin film of naphtha; but we believe that the oil that we have employed is preferable, for we have used it on volatile liquids such as ether, and have not detected any appreciable evaporation.

The tube used by us is 41¼ feet in length and ⅜ inch in diameter. It is in a single piece, and was carried by hand from St. Denis to St. James Tower with the greatest precaution. It was introduced through an aperture formed in the lower part of the tower.

It is mounted upon a board 42½ feet in height and 8 in. in width (Fig. 1). Besides, another board of the same width supports a second tube which is but 6½ ft. in length. The two tubes are connected by a U-shaped copper tube. As the reading cannot be done as in all ordinary barometers, the variations are observed in the second tube. Upon the board to the right is arranged the vernier (Fig. 2) as well as the needle (Fig. 3).

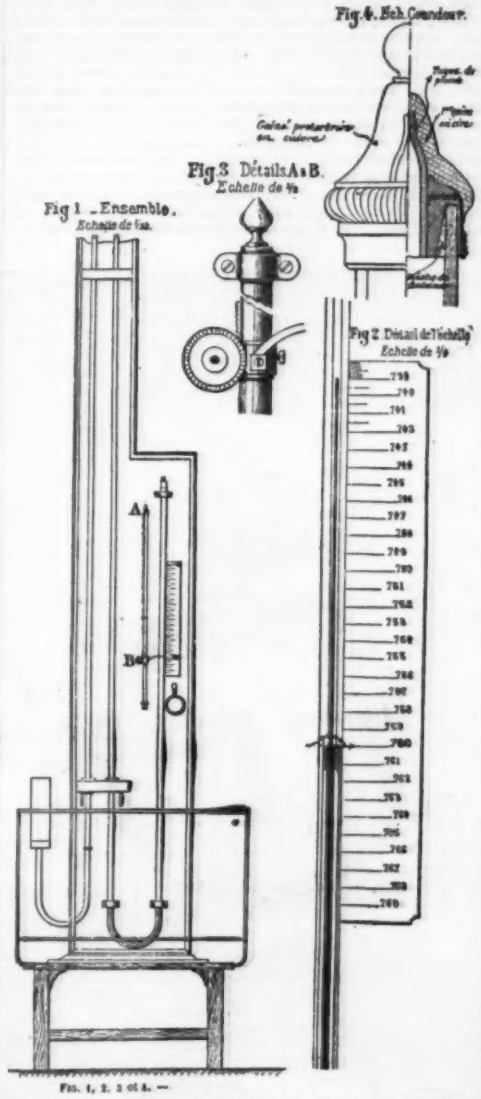
The most important part of this work was the filling properly so called. The small tube was first completely filled and then corked; and then the large one was filled, and afterward closed with a metal plug surrounded with rubber to prevent the contact of the metal and glass.

In this plug was arranged a tin tube 8 in. in length and filled with oil. On flattening the extremity of the tin tube, we thus had a tube entirely full; and it sufficed to open the bottom to see the level establish itself automatically.

The closing of the top (Fig. 4) was rendered more hermetical by means of wax and a copper cap.

The observations that this barometer permits of making are most interesting, and it is especially at the approach of storms that it is curious to consult it.

The tube to the left of the engraving is that of a glycerine barometer which is now in course of prepara-



WATER BAROMETER OF ST. JAMES' TOWER.

tion and which will register the pressure automatically. —*J. Jaubert, in Le Genie Civil.*

THE WALKER ENGINEERING LABORATORIES.

THE Walker Engineering Laboratories, in connection with University College, Liverpool, were opened on November 2. The ceremonies of the day consisted of a luncheon in the drawing room, the address by Sir John Coode, and the formal opening of the laboratories.

In opening the proceedings the Earl of Derby alluded to the fact that over a quarter of a million sterling had been subscribed within the last ten years in aid of the college, in and around Liverpool alone. Prizes were subsequently distributed to the college students. The evening ceremony consisted of a well-attended conversazione, at which a statue of the Duke of Albany was unveiled by Lady Walker, prior to the formal opening of the laboratory. This latter was achieved by Lady Walker.

The Walker Engineering Laboratories consist of a building of three stories, 60 ft. by 100 ft., and an annex of one story, 100 ft. long, the latter being the wood-working department, which was completed and opened about a year ago. The main building consists of three floors, and is built in terra-cotta and gray brick, of which the whole of the future college building will be constructed, and of which the new infirmary, as well as the chemical laboratories, are already built. The chief building is very fine, appropriately but not profusely ornamented. Mr. Waterhouse being the architect, the view that all things pertaining to engineering should be as ugly as is compatible with utility has found no favor here. The general arrangement of the interior, which is presumably to be attributed to Professor Shaw, is no less admirable.

From the address of Sir John Coode we make the following abstract:

"Speaking of energy, let me say a word or two by way of encouragement in the practice of healthy bodily exercise. This has long been a matter to which, with the best possible results, much greater attention has hitherto been directed elsewhere than in our own country, more especially in Germany and in America. It is not my intention to enter upon the controversy which has recently been somewhat fiercely raging around us, on the subject of 'compulsory games in public schools;' but believing, as I do, that there is a more intimate connection between the *corpus sanum* and the *mens sana* than is generally recognized, I trust none of the students of this college or university will neglect any of the opportunities that may be afforded them in the way of gymnastic exercises and healthy games. May I here venture to state a few facts as to what has already been done in the United States of America, to which reference has just been made? It appears from a paper recently read before the Anthropological Society of New York that the four universities of Harvard, Amherst, Cornell, and Princeton have between them spent 250,000 dols., or £50,000 sterling, in making such provision as they have considered to be desirable for enabling students, so far as possible by such means, to acquire a sound and healthy body, and the minor seats of learning are imitating the example set by the universities. In the great Cornell University, at Ithaca, in the State of New York, where there are now upward of 1,200 students, special attention is given to 'physical culture,' so much so that there is an 'acting professor' charged with attention to it. It would be quite out of place to attempt to give more than a very general idea of what is done there in this respect; it will, I think, be impossible to convey such an idea better than by quoting from the report for the academic year 1887-88: 'The student is examined on entering the university, also during senior year, and at some intermediate point in his course. . . . The examination consists of a careful record of the name and age of the student, condition of health past and present, questions as to hereditary possibilities, nature of diseases from which he may have suffered, surgical accidents, and a general research into matters of personal hygiene. There are then recorded his weight, six items of heights, twenty-three girths, six breadths, eight lengths, five strength tests, and his lung capacity. The measures thus taken enable us by comparison with the average results of measures made from about ten thousand examinations of American college students to determine how far from this standard of the typical or average student our applicant diverges.' It appears, and this seems to me to be especially interesting, that attention is given, not only to the physical training of the typical or average student, but also to the correction, as far as practicable by judicious means, of physical defects, for the report goes on to say: 'We can now, with these figures before us, prescribe understandingly for physical deficiencies in our students. We are able to tell a student suffering from such deficiency, not only as a matter of judgment, that his lung capacity is small, or his chest flat, but we show him the actual figures. . . . By a comparison of these measurements with a known standard, combined with the judgment of the director, . . . men from each incoming class are selected because of their marked physical incompleteness, and for them work especially adapted to their varied needs is prescribed.'

"While the necessity for fostering the development of energy is admitted on all hands, there is a matter having a detrimental tendency—that is, the increasing use of tobacco by growing English youths—which is not, as I believe, sufficiently recognized; it therefore appears to me that a few words ought to be said on this subject. Let it be clearly and distinctly noted that I say nothing here on the vexed question of the use of tobacco by those of riper years; the facts I shall adduce, and I shall content myself with quoting a few facts, have reference solely to those who have not attained to full manhood. Taking thirteen separate classes embracing those of rhetoric, natural philosophy, and mathematics, from five different lyceums and colleges in France, it was found, during the period between the years 1877 and 1880, that out of a total of 205 of the more advanced pupils, the 'outcome'—to use an expressive Americanism—stood thus, the figures being the means or averages: The ratio of successful to non-successful students was, in the case of non-smokers, as 1 to 5; of the moderate smokers, as 1 to 7¼; and of the great smokers as 1 to 10. It would therefore appear that the prospects of success are 2 to 1 in favor of the non-smokers, as compared with the great smokers. Referring to another set of statistics obtained from the school of Ponts et Chaussées, the students, having, by a supreme effort, succeeded in effecting an entry, are certain of employment under the government in some shape, as a rule, relax their efforts in a greater or lesser degree. Bearing this in mind, let us see what were the results for 1878, the only year of which the details are available, and we find that those who lost ground stood in the following proportions, viz., non-smokers, 2½; moderate smokers, 27; and great smokers, 38. In the State of Connecticut, in America, it was enacted that any person selling, giving, or supplying tobacco, in any form, to any one under sixteen years of age, was liable to a penalty of 50 dols.—£10 sterling.

"Regarded from the standpoint of the civil engineer, we are here, if I may be allowed so to express it, on the 'classic ground' of railways, Liverpool having been one of the termini of the first example of the wonderful system of railways for the transport of passengers, of which it is not perhaps too much to say that it has contributed more to the 'use and convenience of man' than any other contrivance or device which has been conceived and wrought out by human genius and skill. In 1825, when George Stephenson declared to a committee of the House of Commons that, if permitted, he could make a locomotive travel at the rate of twelve miles an hour, it was said of him, and said with all seriousness, 'the man must certainly be laboring under a delusion.' In 1889 trains are one might almost say hourly running over this identical line of country, so familiar to many, if not most of you, at five times the speed regarded by some people with such dismay in 1825; as for the effect upon the cattle in the fields and meadows—well, we need not waste time in discussing that subject. And here I should like to be permitted to remark that it is, to my mind, especially interesting to look back upon the struggles and difficulties encountered by George Stephenson, that would have vanquished any ordinary man; it is interesting, I say, to look back and see how, under the long-continued fire

of subtile argument and taunting ridicule, from the lips of some of the most talented pleaders at the bar and members of the senate, his faith never faltered for one moment; not only was he never daunted by the severest criticisms or by scoffing ridicule in the preliminary stages of this then novel undertaking; but when amid the formidable practical difficulties encountered at Chat Moss his subordinates seemed to despair, George Stephenson, and he alone, never once wavered or lost confidence in the ultimate accomplishment of that success which he so ably attained and so richly merited. It was only in the year 1830 that the first railway in the world, constructed, avowedly, for the conveyance of passengers, was opened between this city and Manchester, a distance of thirty-one miles, whereas there are now in the United Kingdom alone, in actual working, no less than 20,000 miles, upon which have been expended a sum of £866,000,000—£160,000,000 more than the entire national debt at the present time."

Sir John then gave a long and interesting account of the greater or at all events the salient, achievements of the engineer and the great works in progress. This we reluctantly have to omit. In concluding, he said: "I have dwelt mainly upon the technical aspects of engineering work; but remember that for the highest success something more than a knowledge of technicalities is essential, that the engineer's vocation brings him into contact with men and minds of other nationalities and other languages, that a knowledge of French and German will open to him invaluable sources of information which must otherwise remain a closed book, and not seldom acquaintance with foreign tongues proves the 'Open sesame' to an honorable career; that in our profession, as in others, the highest distinctions are reserved for the engineer who is likewise a gentleman; and that one sure mark of the gentleman lies in the possession of a wide and liberal culture.

"It may be, perchance, that some of you may have to face repeated discouragements; nevertheless, persevere: Let your motto be, in a word, 'Excelsior!' And, by way of parting counsel, let me recommend to you a passage from the grandest repertory of wisdom the world has ever seen, 'Whatsoever thy hand findeth to do, do it with thy might.' Acting upon this as a guiding and ever-present principle, not only so long as you may be studying here, but in your subsequent career, you may enjoy the lifelong satisfaction that, in this one respect, at any rate, you will have done your duty in that state of life to which God has been pleased to call you.

[THE ENGINEER.]

THE TWIN SCREW STEAMER COLUMBIA.

WE have great pleasure in placing before our readers an engraving of the fine steamer Columbia, for which drawing we and our readers are indebted to the courtesy of Messrs. Laird Brothers, of Birkenhead, the builders. The engraving of the Columbia at sea is copied from a fine painting by Mr. C. K. Miller of Glasgow.

When the Hamburg-American Company addressed its inquiries to Messrs. Laird, it merely specified the number of passengers of each class to be carried, the speed at sea, and the draught of water; all other elements of design, such as dimensions and arrangement and mode of propulsion, were left to Messrs. Laird, and having been allowed a free hand, they have, in the Columbia, embodied their vast experience of twin screw propulsion. Having inspected the Columbia in dry dock, and by examining her model, it is difficult to conceive a more beautiful underwater shape. In fact, her whole appearance is most graceful and yacht-like. The three pole masts and three oval funnels give one an impression of speed and power. The Columbia is 470 ft. long, 56 ft. beam, and 38 ft. 6 in. deep moulded. When laden she draws 24 ft. of water, and at that draught displaces about 10,000 tons.

Notwithstanding her great beam, which renders her an unusually stable vessel, her block coefficient is remarkably small, being but 0·55. This gives one an idea of her exceedingly beautiful lines. She has a slightly raking stem and the usual elliptical stern. She is built throughout of mild steel. The framing is of the usual transverse description. She has no external keel, but two bilge keels are fitted. The bottom is formed of a flat keel plate, with a vertical keel plate extending throughout the length of the ship. A double bottom is built level to the top of the keel plate, which is watertight, thus dividing the double bottom into two sides. The space between the two skins is strengthened by four intercostals on each side. The ship is divided into twelve watertight compartments by eleven bulkheads, extending from the upper deck to the outer skin. In the double bottom this, of course, forms the ballast tanks, which, with the deep longitudinal keel plate, enables the ship to be trimmed in any direction. She has a capacity for 1,020 tons of water ballast in eighteen compartments. It is, perhaps, late in the day to enlarge upon the great value of double bottoms in the event of stranding. In the bows the plating is doubled from the garboard to the water line, and inside, the frames are more closely spaced to obtain additional strength in the event of colliding with ice. The stern frame and propeller brackets are of cast steel from the West of Scotland Steel Company.

There are four complete decks of steel plate, with teak planking; the distance between the decks is 8 ft. 6 in. The orlop deck is worthy of mention, as it is fitted with watertight scuttles beyond the double bottom, rendering it a watertight flat. This is of enormous advantage, and, so far as we are aware, the Columbia is the first vessel in the mercantile marine so fitted. On the upper deck forward is the forecastle, plated over, giving a large open deck for working anchors, etc., on the after end of which are fitted the breakwaters and lighthouses. In the latter we noticed that the side lights are hung in gimbals, a system long advocated. Within the forecastle is one of the largest of Messrs. Emerson & Walker's windlasses, worked direct by steam. Connection is also made by means of spur gear clutches and shafting to work the capstan on the forecastle head. It will be remarked that the forecastle head presents a very clear appearance, owing to the windlass being put in its proper position on the upper deck, and not on the topgallant forecastle. Abaft the forecastle is the fore hatchway, surrounded by a deck house to give greater protection to the steerage passengers. Abaft the forehatch is the long deck house, which extends to the afterhatch. In this deck house is the first class dining hall. This gives accommodation for 150 passengers. It is decorated in the highest style of mixed renaissance. Below this, on the main deck, is another first class saloon for fifty passengers, decorated in pure renaissance.

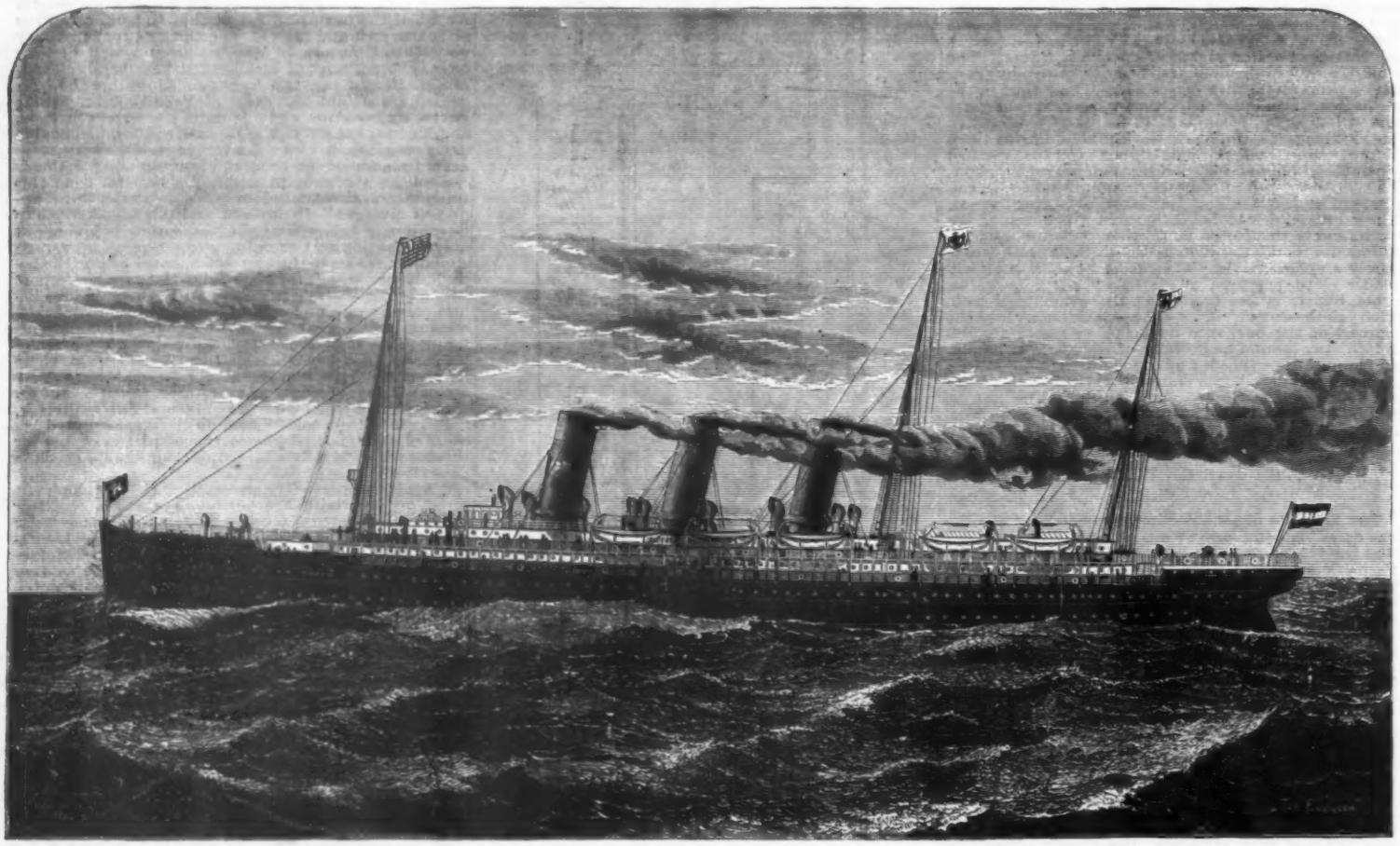
The decoration is throughout of the most sumptuous and lavish character. The panel painting and mirrors in these saloons are used with fine effect, and the upholstery is very elegant in style and color. Above the deck house on the promenade deck are the ladies' room and music room, both decorated in the rococo style, smoking room, bar, state rooms, captain's and officers' rooms. The ship may be described as a flush deck ship, with topgallant forecastle, poop, and long bridge house, the roof of which is extended to the sides, forming the promenade deck, which is 350 ft. in length. She is built to the requirements of the Bureau Veritas.

It is impossible to give a full description of the saloons, etc. All the decorations are really works of the highest art, and the designs are by the best artists of the German school. The furniture and the whole of the decorative work has been supplied by Bembe, of Mayence, and is in strict keeping with the style of decoration. We have no hesitation in saying that the Columbia is, without doubt, one of the best appointed vessels on the Atlantic. All the first class state room cabin furniture, etc., is by Laird Brothers. The second class is unusually good; in fact, equal to the first class of many Atlantic boats. There is a dining hall on the upper deck, and stairways giving access to the ladies' rooms and smoking rooms in the after end of the promenade deck. The panels of these rooms are carved by hand in hard wood, and most handsomely decorated. The first class smoking room is a luxurious apartment on the promenade deck; it is upholstered in green morocco.

In the music room is a very handsome grand piano by Steinway. Nothing can exceed the elegance and good taste displayed in furnishing this room. Large oil paintings, mirrors, rich hangings of silk and damask, combine to make it a most luxurious chamber. A great feature in the passenger accommodation is the number of cabins on the upper and promenade decks, and that in bad weather it is never necessary for any one to go on deck. A passenger can obtain access to any part of the ship without being exposed to the weather. None of the doors of the state rooms open on to the weather deck. The lavatory accommodation is extremely good, and a large portion of the fittings are by Shanks, of Glasgow.

The cooking for something like 1,500 persons is done by ranges, supplied by H. Wilson, of Liverpool, and for the crew and emigrants by a large steam galley, by Becker & Ullmann, of Berlin. Butchers' shops, bake houses, and ice room are placed in convenient situations. The fresh water tanks are built into the ship, and have a capacity of 37,000 gallons. In addition, there are separate fresh water condensers. All the cabins throughout the ship are heated by steam heaters, by A. & R. Brown, of Liverpool. There are four side hatches and three middle hatches for cargo purposes. Each hatch is supplied with derrick and winch, these latter being Emerson & Walker's, and fitted with helical pinion teeth. Deck pumps worked by hand are supplied by Stone, of London. In the poop are the steerage, hospitals, lavatories, and the steam-steering gear, and on the poop deck are two warping capstans by Emerson & Walker. The rudder and steering arrangement is very good, and struck us as being a decided improvement. The rudder frame is of steel, plated and fitted in the usual manner. To facilitate unshipping it in dry docks not fitted with rudder wells, or to enable it to be unshipped in port, the rudder spindle is in two portions, connected by a large coupling. On the rudder spindle head is a circular tiller 16 ft. in diameter. On this are the steering chains. The steering engine is by Muir & Caldwell. The engine drives a shaft carrying a worm, which gears into a large wheel.

On the spindle of the latter is a spur wheel which gears into two others. The axis of the small one is in the fore and aft midship line, and makes, with the axis of the larger ones, an angle of about 60°. These two large spur wheels are each keyed on a drum, on which



THE NEW STEAMSHIP COLUMBIA—10,000 TONS DISPLACEMENT, 12,500 H. P.

is wound the steerage chain. By this arrangement the chains are not led round corners. The lead is direct. On the upper bridge is the steering wheel, which works a shaft running to the poop. To take up any play or violent motion of the rudder a pair of Maginnis brakes are fitted. These in other vessels have got a very good reputation for themselves. The anchors are carried on sloped beds on the forecastle head, and are secured in the usual way. They are of Trotman's well known make, and weigh 4½ tons each. Spare best bower and kedge anchors are supplied. There are ten steel lifeboats of very large size, fitted with Hill & Clark's gear. The lifeboats are carried on the rail, and in the keels are slots, and a locking apparatus, worked by a handle, keeps them in position. The chocks for the boats are carried on movable stanchions. The davits are placed at the bow and stern of the boats; the davit space is worked by a tackle, and two simple movements suffice to throw the boat far clear of the side. The arrangement is, we understand, that of Captain Andrews, of London. There are nine main steel boilers, in three groups of three each, and each group, together with its coal supply, is placed in a separate water-tight compartment.

Six of these boilers are 17 ft. 3 in. long and 15 ft. 4 in. diameter, and the remaining three are the same length, but 14 ft. 3 in. in diameter. All the boilers are double ended, fired fore and aft. In these boilers very great care and attention on the part of the builders during construction was necessary, as the German authorities require dimensions, scantlings, and work much in excess of Lloyd's or the Board of Trade. In each boiler there are six Purves ribbed flues. The total heating surface is 35,000 sq. ft., and total grate area 1,220 sq. ft. The working pressure of steam is 150 lb. per square inch. Each group of boilers is supplied with a separate feed pump, and temperature compensator or feed heater. Feed injectors are also fitted to each boiler. The main steam pipes are so arranged that any one boiler or group of boilers can be used or shut off as the case may be.

As regards the main steam pipes, they are of copper, and very great care has been taken with their construction, and, as an additional precaution, we notice that each pipe is served over with crucible steel ⅛ wire. In our opinion this is a most commendable practice. We know that wire coiled on a gun adds enormously to its strength, and in the case of steam pipes a very great accession of strength to resist bursting force is gained. The screws are revolved by two sets of triple expansion engines, each set capable of developing 6,250 horse power. The cylinders are 40 in., 66 in., and 101 in. in diameter; stroke, 66 in. All the cylinders are jacketed. The cylinders are carried on extremely massive double-legged box columns. The bed plate and columns are unusually strong; in fact, it is not difficult to see that all the machinery is of dimensions very much in excess of that actually required, the idea being in keeping with Messrs. Laird's practice, which is to provide a large excess of strength in everything. The wisdom of this was well illustrated when these enormous engines were running at full speed. The vibration was hardly perceptible even at the stern, and in the ladies' cabin it was difficult to determine whether the engines were running or not. Steel is freely used in the moving parts of the machinery.

The reversing gear is by Allen, and is very rapid and noiseless in its action. The shafting is of steel and is hollow. It was made by Krupp, of Essen. The crank shaft is 20½ in. diameter, the tunnel and propeller shafting being 19½ in. and 20½ in. in diameter respectively. The thrust block is unusually large, and is of the adjustable open "horseshoe" pattern. All the main shafting bearings are of white metal, and ample surface is provided. The glands in the engines are packed with the United States company's metallic packing, and throughout the long trial trip, with the engines at full speed the whole time, all the glands not only remained tight, but the piston and slide rods were as bright as possible, and no trouble was experienced on this head whatever. Chadburn's deck and engine room telegraphs are supplied, also helm and bridge telegraphs.

Chadburn's engine room counter is used, and on the bridge Alison's motograph—a very useful and ingenious invention—is supplied for each engine. The motograph is of simple construction, and is actuated by a current of air contained in a copper tube leading from the engine room to the bridge. It is of great value to the captain, officer, or pilot on the bridge, as it at once assures them that their orders are being executed, and removes all anxiety on their part as to which way the engines are going, thereby enabling the officer in charge to at once have the engines stopped or reversed, and thus avoid collision or other damage that might occur from any misunderstanding of the orders transmitted from the bridge. The motograph also shows on the bridge the number of revolutions the engines are making. It also registers the direction in which the engines were last moving—ahead or astern as the case might be—and remains so until the engines are again reversed, and it also obviates the necessity of a man standing by in the engine room to reply to the bridge, the engines themselves automatically indicating the reply on the motograph.

Lubrication on the main engines is most ingeniously effected by means of Bischoff's lubricators. Auxiliary condensers are placed in each engine room to take all the exhaust steam from the winches and small engines, galley, etc. Each of these condensers is fitted with an independent air pump and circulating pump. An excellent installation of fire pumps is supplied. The engines are separated by a water-tight bulkhead, extending to the upper deck. Above the bulkhead is a passageway running fore and aft, in which are the quarters for the firemen. Baths and wash houses are supplied for them, and such are the good arrangements made that it is never necessary for them to go on deck, and they are thus protected from unnecessary exposure. The arrangements for the ashes and refuse is very good. In each stokehold is one of Higginson's ash hoists. A trunkway in the middle line of the ship leads down and then divides into two arms, which go to the side of the ship. Flaps and outside doors are fitted, and the ashes are thus got rid of without annoyance or exposure to any one.

The slides for the high pressure and the intermediate pressure cylinder are of the piston type, and in the low pressure cylinder the long D slide is fitted with a balance back. All the slide rods are balanced. The slide valves are worked by the ordinary link motion of the single bar type. Tail end piston rods for the cylinders are not fitted, but the shoes on the piston rod heads and the guide plate of the column are given very large surfaces. The pistons themselves are very deep. Condensers are placed at the back of the engines, and are of the usual surface pattern. The air pumps are driven by a rocking lever off the H and L crossheads. These are the only engines driven in connection with the main engines. Bilge, feed, and each circulating pump are driven by a pair of independent engines, made to a special design by Messrs. Tangyes, who have supplied many similar engines to Messrs. Laird. There are two three-bladed steel propellers, their diameter being 18 ft. and 32 ft. pitch. The total blade area is 186 square feet, and the total disk area is 509 square feet. The bosses are of steel, and are 4 ft 6 in. in diameter. The bosses are recessed to admit the flanges of the blades. They are so constructed that when the blades are fitted, the boss is as spherical as possible; covers are fitted on the after end of the bosses, and the whole is a very complete job. A peculiar feature in the stern is that there is an aperture similar to that in the single screw vessels. This aperture is of great service, as it enables the propellers to be run at greater efficiency, besides preventing any vibration. It also facilitates the turning of the ship. A distinguishing feature of the Columbia is the excellent electric light installation. It is seldom, indeed, that such a complete plant is seen, except on board war ships.

The plant consists of three sets of combined engines and dynamos, supplied by Von Bremen in conjunction with Siemens Brothers, of London. The dynamos are compound wound, and are Siemens latest type. Current is delivered at an electromotive force of 110 volts. The plant is in duplicate, the third set being for daylight use. The spindle of the armature revolves in long phosphor-bronze bearings. The engines are compound vertical and direct acting. The shaft is coupled direct to the armature spindle, and engines and dynamo are bolted to one bed plate. These engines are of very good design and make. The cranks are balanced, and massive flywheels are fitted. The engine and dynamos make 350 revolutions per minute. The main cables are led to a large slate-based hard wood main switchboard.

Each circuit has its own main switch cut-out, voltmeter and ammeter, these last being "dead beat" in their action, and are by Shaffer & Budenberg, who also supply all the gauges used throughout the ship. The lamps are incandescent 110 volt lamps, by Edison & Swan; they are of the "capped" kind.

For the saloons frosted globes are fitted. Group lamps are supplied for the masthead and side light. While running the light was wonderfully steady, and no fluctuations in the current could be detected. All the lamps are of 25 candle power. All the cables and leads are inclosed in hard wood casing, and the insulation is of the highest class. Something like six miles of cable are used throughout the ship, the switches and contents being of very good design and make. A complete set of electrical bells, etc., is fitted throughout the ship. On her trial trip the ship made two runs between the bar lightship and the northwest lightship. The engines made 74·0 revolutions, giving true mean speed of 19·05 knots. Then a run from the northwest lightship was made to Point Lynas. The average revolutions were 75·5, giving a speed of 20·0 knots, or an average of a run of 45 knots continuous steaming gave 19·77 knots. During the whole of the trial the boilers made steam easily, and the safety valves were lifting all the time. No stoppage on account of hot bearings occurred; in fact everything passed off without the slightest hitch.

Since the Columbia started on her first voyage, July 19, 1889, she has completed three voyages to New York and back. The daily running time occupied on voyages and average speeds are given in the following statement. This gives the average speed on voyage, taking all weathers. When in good trim at the end of a voyage she has twice run the distance from Southampton to the Elbe, a distance of 411 knots, in 20 and 20¼ hours, giving a speed of 20·55 and 20·04 knots per hour respectively. Report from ship after last voyage says: "Everything satisfactory; engines working uninterruptedly smoothly."

	First voyage.		Second voyage.		Third voyage.	
	Southampton to New York.	New York to Southampton	Southampton to New York.	New York to Southampton	Southampton to New York.	New York to Southampton
	knots.	knots.	knots.	knots.	knots.	knots.
First day	150	28	373	372	375	378
Second day	443	418	473	427	448	434
Third day	461	431	476	456	453	427
Fourth day	474	433	453	430	392*	426
Fifth day	464	447	459	449	451	430
Sixth day	450	453	474	433	473	425
Seventh day	459	447	344	434	457	432
Eighth day	169	429	—	119	—	25
Total distance	3,073	3,086	3,042	3,086	3,049	3,078
Time occupied	d. h. m. 6 21 25	d. h. m. 6 19 0	d. h. m. 6 18 20	d. h. m. 6 22 30	d. h. m. 6 23 57	d. h. m. 6 22 30
Average speed	knots. 18·39	knots. 18·96	knots. 18·75	knots. 18·53	knots. 18·16	knots. 18·5
Speed on best day	19·15	19·49	19·23	19·31	19·11	19·44

NOTE.—The falling off on day marked * was due to three of the boilers being shut off for several hours, owing to the breakage of a valve.

NOTE.—Forty-five minutes is added to each day going to the westward and is deducted coming east, to allow for difference in longitude.

IRRIGATION IN CALIFORNIA.*

By WM. HAMMOND HALL.

MR. PRESIDENT AND GENTLEMEN OF THE SOCIETY: When I was invited to address this society, I had no material at hand on the subject. I have come to the East without any notes or memoranda whatever from which to prepare a lecture or address, no statistical data which would make a paper valuable, no notes of characteristic facts to render an address interesting, and no time to write anything to guide me in any way to a proper treatment of the subject. Some of your members have thought that I have written something worthy of being read, and hence this invitation to address you. But, even if they are right, people who can write cannot always talk, so if I fail in this address, I shall hope, on the basis of their opinion, that you will find in the reports I have written something worthy of reading. The subject has been announced as the "Problems of Irrigation in the United States." I should like very much to speak broadly on that subject, but I am unable to do so, for the reasons I have given, and shall have to speak rather of irrigation in California, trusting that something which is said may, perchance, be valuable in relation to the subject at large. Irrigation in the far West generally is attracting a vast deal of attention. This is particularly the case on the Pacific coast—the field with which I am specially acquainted. I apprehend that although many gentlemen present have a far-reaching and definite appreciation of the subject at large, many others do not appreciate the value and importance of irrigation. In the arid parts of California (for we do not admit that California is as a whole arid) it is a vital matter. There it is a question of life for the people. Not more than one-sixth of the tillable area in the State can sustain a really dense population without irrigation; two-thirds of it will not sustain even a moderate population, without irrigation; while one-third will not sustain even a sparse population without such artificial watering. Think well over these facts. They are very significant. I doubt whether they are generally appreciated in California itself.

I have no doubt many persons are familiar with the geography of the State, but, doubtless, some are not. California has a coast line of 800 miles and a width of from 140 to 240 miles. It is traversed almost throughout its length by a great mountain chain extending along near the eastern boundary, which is called the Sierra Nevada, and by a lesser range, more broken and less unified, running parallel to the coast, called the Coast Range, the southern extension of which, after joining the Sierra Nevada, is called the Sierra Madre, and at the further extremity, the San Jacinto and San Diego mountains. Within the interior of the State, looked down upon by the Sierra Nevada on the east and closed in by the Coast Range on the west, is the great interior basin—the valley of the San Joaquin and Sacramento rivers—forming a plain 450 miles long, with an average width of from 40 to 60 miles. Outside of the Sierra Madre in the southern part of the State, and within the Coast Range, is another interior valley, nearly 100 miles in length and from 20 to 30 miles in width; and outside of the Coast Range, and lying next to the ocean, is a plain whose length is from 60 to 70 miles, and width 15 to 20 miles. These three areas—the great interior valley, the southern interior valley, and the coast plain of the south—are the principal irrigation regions of the State. Numbers of smaller areas, as those in San Diego county, come in as irrigation regions of less importance, and the scattering valleys along the Coast Range farther north, as the Salinas, etc., will come forward in the future as important irrigable districts of the State. Still further north, in the interior, there are the great plains of Lassen and Mono counties, and some scattering valleys in Shasta county, where irrigation is also practiced or is being introduced, and these are on a par with the districts of San Diego county, in the matter of rank as irrigation regions.

East of the Sierra Nevada, and at their base, lies the Owen's river country, an area suitable for irrigation, where irrigation is necessary, and where it is being introduced.

Upon the great Mojave desert and the Colorado desert there is at present no irrigation. The water supply is very scanty. This is an irrigation region of the future, but it is not regarded by Californians as a practicable one at present.

With this general idea of the State, we will now look at the rainfall and water supply. The State contains 157,440 square miles of territory, of which 17,747 drain into the ocean north of the Golden Gate, 21,665 drain into the ocean south of the Golden Gate, 55,942 drain into the interior basins, and 62,086 drain out at the Golden Gate.

Of this territory which drains out by the Golden Gate, 26,187 square miles comprise the Sacramento valley, 31,895 square miles the San Joaquin valley, and 4,004 the country draining directly to the bays, making the 62,086 given above as the whole area.

The necessity for irrigation in California and the relative necessity in other parts of the State are shown by the distribution of rainfall. The San Joaquin valley has an average of less than 10 inches of rainfall, the Sacramento has an average of between 10 and 20 inches.

The great deserts of Mojave and Colorado have an average of less than 10 inches, and in certain localities only 3 to 6 inches.

The Salinas valley, a small portion of the coast above Los Angeles, and a portion of the interior valley of the south, have also an average of less than 10 inches.

So we may say that the great irrigation regions of California have average amounts of rainfall varying from about 6 up to 20, but generally less than 10 inches.

This rain is distributed in four or five months of each year, with some slight showers in one or two months other than these, the remainder of the year being absolutely dry, with no rainfall whatever. Hence, you will see at once the necessity for the artificial application of water in California. In the older countries of Europe, where irrigation has been practiced for centuries, for instance, in Spain, where water is used more extensively than in California, the annual mean rainfall ranges between 10 and 25 inches. In the irrigation regions of France, the mean rainfall ranges from 10 to 40 inches; in the irrigation regions of Italy, the rainfall is between 20 to 35 inches; for instance, in the valley of the Po, the classic land of irrigation, the annual precipitation is from 25 to 35 inches. There are none of these European irrigation regions where the rainfall is less than 10, and generally it is over 20 inches. But you will see that the most of the Californian irrigation regions have less than 15 inches, some less than 10, and the greatest rainfall of any large irrigable region in California is 18 inches, or, exceptionally, for smaller regions, 25 inches; while in Europe, the maxima are from 25 to 40 inches in countries where irrigation has long been practiced.

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It follows, then, that there is no place in Europe where it is so much needed as over a large part of California. Another reason why the necessity is felt in our Pacific Coast State is found in the character of our soils; and not alone the surface soils, but the base of the soil—the deep subsoils. We have soils exceptionally deep; soils which extend below the surface to 50 feet, underlaid by loose sand and open gravels, so that the rainfall of winter is lost in them. The annual rain seldom runs from the surface. It follows that these lands are generally barren of vegetation without the artificial application of water.

Considering now the sources of water supply: we have in the southern part of the State many streams which flow only for a few weeks after rainfall, and other streams which run two or three months after the rainy season. But there is not a stream in all California south of the Sierra Madre (except the Colorado, which has its sources of supply outside of the State) which flows during the summer with a greater volume than about 70 to 80 cubic feet per second—a stream 15 feet in width, 2 feet deep, and flowing at the rate of 2½ to 3 feet per second—a little stream that in the eastern part of the continent would be thought insignificant.

The largest stream for six months in the year, in all southern California, is the Los Angeles River. The Santa Ana river, the next largest, flows from two-sevenths to one-third as much; the San Gabriel, the next largest, has perhaps two-thirds or three-fourths as much as the Santa Ana; and so a stream which will deliver as much water as will flow in a box 4 feet wide and 1½ feet deep, at a moderate speed, during summer months, would be regarded as a good-sized irrigation feeder in that southern country. In the great interior basin or central valley we find other conditions. Here we have a different class of streams. The great Sierra Nevada receives snow upon its summits which does not melt till May or June and July. The melting of these snows is the source of supply of the streams; so that, while in far southern California, with two or three exceptions, the greater flow of water in the streams is almost gone by June, in this central region it is the period of the height of irrigation, and the streams are flowing at their maximum.

Kern River presents about 2,000 to 3,000 cubic feet of water per second; King's River presents in the maximum flow of the season about twice to three times as much as Kern River; the Tuolumne River, about as much as King's. As we go farther north, the Sacramento River presents more than three times as much as the Tuolumne, so that in the northern part of the great valley, where the rainfall on the valley itself is greatest, and, consequently, the necessity for irrigation is least, the irrigation supply increases; and conversely, the greatest area of irrigation in the valley and the greatest necessity for it is, in general, where the water supply is least.

About one hundred years ago irrigation was commenced in California. The Roman Catholic priests, coming from Mexico, where irrigation had long been practiced, introduced it. They established missions among the Indians, started cultivation, and by the labor of these Indians built the original irrigation works.

The practice of irrigation was extended in San Diego county, as far as we are able to trace, to several thousand acres; in San Bernardino county, in the southern interior valley, they thus cultivated and watered, perhaps, 2,000 acres; and in Los Angeles county there were possibly 3,000 acres irrigated under Mexican rule.

Traces of the old mission works are found in San Diego, San Bernardino, and Los Angeles counties, and as far north as Monterey county.

Then came the gold fever, when canals were dug throughout the foot hills of the western slope of the Sierra Nevada, for the supply of water for the mining of gold; and these canals have since, in many instances, been turned into feeders for irrigation. Several thousand miles of irrigation ditches have thus been created from old mining ditches.

In 1852, a band of Mormons came from Salt Lake into the San Bernardino valley; they bought a Mexican grant rancho there, took possession of some old mission works, constructed others, and started irrigating.

This was probably the first irrigation colony, on a large scale, composed of others than Mexicans, in California.

In 1856, some Missouri settlers went into the valley of Kern River, diverted water from that stream, and commenced irrigation upon a small scale.

In 1858, the waters of Cache Creek, in the Sacramento valley, were taken out for irrigation.

In 1859, the waters of King's River were taken out and utilized for irrigation. These instances represent in general outline the commencement of irrigation in the State. Now we have in the neighborhood of 750,000 or 800,000 acres actually irrigated each year, and that represents what would ordinarily be called an irrigation area of 1,200,000 acres; and there are commanded by the works—reasonably within the reach of existing canals—an area of about 2,500,000 acres.

In the organization of irrigation enterprises there is great diversity. Commencing with the simplest form, we have a ditch constructed by the individual irrigator for his own use; we have then successively ditches constructed by associated irrigators without a definite organization, for the service of their own land only; ditches constructed by regularly organized associations of farmers, with elected officers; works constructed by farmers who have incorporated under the general laws of the State and issued stock certificates of ownership in the properties for the service of the stockholders only; works where incorporations have been formed for the purpose of attaching water stock to lands that are to be sold, bringing in the element of speculation; then works where the organization has been effected with a view of selling water rights; and finally, organizations that are incorporated for the purpose of selling water.

There is a difference between the principles of these methods of organization, and the practical outcome is a great difference in the service of water and in the duty of water furnished by them.

In selling water, measurement of volume is made by modules—the actual amount of water delivered is measured—or it is sold by the acre served, or in proportional parts of the total available flow of the season.

The general character of the irrigation works of the State varies very much with the varying conditions under which it is practiced. In the San Joaquin valley, King's River, for instance, comes out of the mountains nearly on a level with the surface of the plain, cutting down not more than a few feet below its banks; and hence but little labor is required to divert its waters out upon the lands to be irrigated; but farther north, the Tuolumne, as another example, comes out of the mountains in a deep canon, and the foot hills extend far down the plain on each side. It is easily seen, then, that it will require a million or more dollars to divert from the latter stream the amount of water diverted from King's River by the expenditure of a few months' work by a small force of the farmers themselves.

On King's River, individual and simple co-operative effort is sufficient to bring water enough upon the plains to irrigate thousands of acres, while in the case of the Tuolumne River it is absolutely necessary to have associated capital in large amount—an entirely different principle of organization from that which was originally applied on King's River and the Kern and other rivers in the southern part of the great central valley.

In discussions on the subject of irrigation some people have advanced the idea that the works should be undertaken by the farmers, and that capital should have nothing to do with them. That may do very well where the physical conditions will admit of such a course, and where nothing but the farmers' own service depends upon it; but the great majority of the streams of California are of such a character that the work of the farmers can avail nothing. There must be strong associations and large capital. For this purpose special laws are required.

On the Santa Ana, in San Bernardino county, water has been easily diverted, and such is the case with every stream in the interior valley of San Bernardino and Los Angeles counties.

Capital for the first works was not required. The water was procured by primitive methods and the works were simple. But in San Diego, an entirely different condition of affairs prevailed. There the waters are back in the mountains, twenty or twenty-five miles from the coast, and the irrigable lands are close along the coast, or within ten or twelve miles of it. To bring the water out of these mountains requires the construction of ditches following the mountain sides for twenty to thirty-five miles.

But simple ditches do not answer, because of the great quantity of water lost from them. So the companies have resorted to fluming, and even to lining the ditches with cement. Thus in San Diego individual effort is out of the question.

Farther north again, in the great interior valley, King's River is a stream where co-operative and individual effort has been efficient, although it requires a greater amount of capital there than in the southern interior valley. In the southern interior valley, perhaps, $10,000 would often build a ditch and divert all the water that the supply would furnish.

On King's River the works have cost from $15,000 to $80,000 each; on Kern River the works have cost from $15,000 to $250,000 each, and on the Tuolumne they will cost from $1,000,000 to $1,200,000 apiece. On Merced River the cost has beeen $800,000 for one work. Taking the streams from San Joaquin River north, that come out of the Sierra Nevada, up to the northern end of the valley, where the Sacramento River enters it, every important stream comes into the valley within a deep gorge. The beds of several of the northern streams are so filled up with mining debris that diversion from them would be comparatively easy, but in their natural state there is not an important stream north of the San Joaquin which could be utilized for irrigation by any other means than through the agency of capital in large amount.

On the west side of this great valley the tillable strip is comparatively narrow. It is on the lee side of the Coast Range of the mountains. Precipitation is made first on the seaward face of the Coast Range, and then crosses the valley, dropping upon the inland face of the outer range very little more than upon the valley itself, where the precipitation is only about ten inches. So that we have no streams coming out of the Coast Range into the southern part of the interior valley specially noteworthy as irrigation feeders.

But as we go northward the Coast Range becomes wider, and the big mountain basin containing Clear Lake furnishes a large supply of water to Cache Creek, probably enough for 10,000 acres.

Stony Creek flows between two ridges of the Coast Range, and out on to the plains, furnishing about the same amount of water; but still there are no streams from the Coast Range into the valley that are comparable with those of the Sierra Nevada.

In the northeastern corner of the State, on the great plains of Modoc, we have the Pitt River, a stream of very considerable volume, but its waters are in comparatively deep channels, not very well adapted to diversion, and the consequence is, they have been utilized to a very small extent, only on small bottom land farms. The whole stream can be utilized, however, and the country is thirsting for water.

The practice of irrigation in California is as diverse as it could well be. California, as you know, covers a very large range in latitude, but a greater range in the matter of climate and adaptability to the cultivation of crops. In the southern portion of the State, the orange and the banana and many other semi-tropical fruits flourish.

In some localities along the foot hills of the Sierra Nevada, also, those fruits flourish, particularly the orange and the lemon. In the valley of San Joaquin wheat is grown by irrigation, and in some places profitably, and in Kern county quite profitable (were it not for high transportation charges), because the cost of distributing and applying water has been reduced to a minimum. There the lands have been laid out with as much care and precision as the architect would lay out the stones in a building and the mason would place them.

Irrigation is conducted in some Kern River districts with the greatest ease, scarcely requiring the use of the shovel. The lands are so laid off with the check levels that by simply opening gates in the proper order, as the irrigation superintendents know how, the waters flow out and cover the successive plats or "checks" in their order, without leaving any standing water, and finally flowing off without material waste.

This is the perfection of irrigation by the broad or submerging system—a method wherein the slope of the ground is first ascertained, platted by contours, and the checks to hold the water, constructed with scrapers, are then run out on slight grade contours—not perfectly level, but on very gentle slopes.

There is no portion of the far southern part of the State where the check method is applied as it is in Kern county. The practice in San Bernardino is to irrigate entirely by running water in rills between the rows of plants. Orange trees planted 24 to 30 feet apart are irrigated by rills in plow furrows, 5 to 8 between rows, down the slope of the orchard, which slope varies from about 1 foot in a hundred to 4 or 5 in a hundred. In Los Angeles county they make banks about a foot high around each individual tree, forming basins 5 or 6 to 10 or 12 feet in diameter, according to the size of the tree. Into these the water is conducted by a ditch, and the basin being filled, the water is allowed to remain and soak away. The low, nearly flat valley lands, when irrigated, are generally divided into square "checks," without respect to the slope of the ground, and the surface simply flooded in water standing 6 inches to a foot in depth.

In the northern part of the State, in Placer and Yuba counties, clover is grown on hills having side slopes of 10 to 15 feet in a hundred, and irrigated in plow furrows cut around on contours—which furrows are about 5 to 10 feet apart horizontally—and the water is allowed to soak into the ground from each such furrow.

These are the five principal methods of applying water: by the check system; by rills; by the basin method; by the basin method as applied to low valleys; and by contour ditches on hill sides. The method selected for any particular locality is determined, not alone by the crop to be cultivated, but also by the slope of the land and the character of the soil. For instance, on lands where oranges are cultivated, in the southern part of the State, where rills are most generally used, water cannot be applied by the flooding system, for the reason that irrigation would be followed by cracking of the soil, so that the trees would be killed. It is necessary on such land to cultivate immediately after irrigation, and the method of application is governed more by the soil than the character of the crop.

We find in California very marked and important effects following irrigation. For instance, taking the great plains of Fresno, in the San Joaquin valley; when irrigation commenced there twenty years ago, it was 70 to 80 feet down to soil water—absolutely dry soil for nearly 80 feet—and it was the rule throughout the great plain, 20 miles in width and 25 miles in length, that soil water was beyond the reach of the suction pump; now, in places, water stands on the surface, rushes grow, mosquitoes breed, malarial fevers abound, and the people are crying for drainage; and lands whose owners paid from five to twenty dollars per acre for the right to receive water, now need drainage, and irrigation is considered unnecessary. The amount of water taken from King's River, which was, a few years ago, regarded as not more than sufficient for one tenth of the land immediately commanded and that seemed to require it, is now applied to a fourth of the whole area; so that if irrigation keeps on, the time will come when the whole country will require draining.

In a district where water is applied by the broad method, I saw in 1877 enough water by actual measurement of flow put on 20 acres of land to cover it 18 feet deep, in one season, could it all have been retained upon it. It simply soaked into the ground or flowed out under the great plain. Taking cross sections of this country, north and south, east and west, I found that where the depth to soil water had, before irrigation, been about 80 feet, it was then 20, 30, 40 or 60 and more feet down to it. The soil water stood under the plain in the form of a mountain, the slope running down 40 to 50 feet in a few miles on the west and north. On the south and southwest the surface of this water mountain was much more steep. In the Kern River country, we have a somewhat similar phenomenon. Irrigation, in the upper portion of the Kern delta, affects the water in the wells 6 or 8 miles away. As I remember, the effect is felt at the rate of about a mile a day, that is to say, when water is used in irrigating the upper portion of the delta, or of Kern Island, as it is called, the wells commence to rise a mile away in twenty-four hours, and five miles away in perhaps five days.

In the southern portion of the State, in San Bernardino county, at Riverside, we find no such effect at all. There it was 70 to 90 feet to soil water before irrigation, and it is, as a general rule, 70 to 90 feet still. Water applied on the surface in some places has never even wet the soil all the way down, and wells dug there after irrigation had been practiced for years, have pierced dry ground for 25 or 30 feet before getting down to where soil waters have wetted it from below. The consequences of these phenomena are twofold. In the first place, in the country that fills up with water the duty of water—the quantity of land which a given amount of water will irrigate—has increased. Starting with a duty of not more than 25 acres to a cubic foot of water per second, we now find that, in some localities, this amount irrigates from 100 to 160 acres; and that some lands no longer require irrigating. In the southern portion of the State, however, the cubic foot of water irrigates no more than at first, and it is scarcely possible that it will ever irrigate much more. The saving, as irrigation goes on in the far southern portion of the State, will be effected chiefly through the better construction of canals and irrigation works of delivery and distribution. In Tulare valley, the duty of water will increase as the ground fills up.

In Fresno, a county which was regarded as phenomenally healthy, malarial fevers now are found, while in San Bernardino, at Riverside, such a thing is rarely known. Coming to Bakersfield, a region which before irrigation commenced was famed for its malarial fevers—known as unhealthful throughout all the State—where soil water was originally within 15 feet of the surface, irrigation has almost entirely rid it of the malarial effects. Chills and fever are rare now, where before irrigation they were prevalent. What is the reason that where chills and fever prevailed, irrigation has made a healthful country, while where chills and fevers were not known, irrigation has made it unhealth-

ful? I account for it in this way: in the Kern River country before irrigation was extensively introduced, there were many old abandoned river channels and sloughs, overgrown with swamp vegetation and overhung by dense masses of rank-growing foliage. Adjacent lands were in a more or less swampy condition; ground waters stood within 10 or 20 feet of the surface and there was no hard pan or impermeable stratum between such surface and these waters. In other words, general swampy conditions prevailed, and malarial influences followed by chills and fevers were the result. Irrigation brought about the clearing of many of these old channel ways, and their use as irrigating canals. The lands were cleared off and cultivated, fresh water was introduced through these channels from the main river throughout the hot months, and the swamp-like condition of the country was changed to one of a well-tilled agricultural neighborhood with streams of fresh water flowing through it; and the result, as I have said, was one happy in its effect of making the climate salubrious and healthful.

Considering now the case of the King's River or the Fresno country, the lands there were a rich alluvial deposit, abounding in vegetable matter which for long ages perhaps had been, except as wetted by the rains of winter, dry and desiccated. Soil water was deep below the surface. Then irrigation came. Owing to the nature of the soil, the whole country filled up with the water. Its absorptive qualities being great and its natural drainage defective, the vegetable matter in the soil, subjected to more or less continued excessive moisture, has decayed. The fluctuation of the surface of the ground waters at different seasons of the year—such surface being at times very near to the ground surface, and at other times 5 or 6 feet lower—has contributed to the decaying influences which the presence of the waters engendered. The result has been, when taken with the general overgrowth of the country with vegetation due to irrigation, a vitiation of the atmosphere by malarious outpourings from the soil. The advantage of the pure atmosphere of a wide and dry plain has been lost by the miasmatic poisonings arising from an overwet and ill-drained neighborhood, with the results, as affecting human healthfulness, of which I have already spoken. The remedy is of course to drain the country. The example is but a repetition of experiences had in other countries. The energy and pluck of Californians will soon correct the matter.

George P. Marsh, in his "Man and Nature," laid it down as a rule that an effect of irrigation was to concentrate land holdings in a few hands, and he wrote an article, which was published in one of our Agricultural Department reports, in which he rather deprecates the introduction of irrigation into the United States, or says that on this account it should be surrounded by great safeguards. He cited instances in Europe, as in the valley of the Po, where the tendency of irrigation had been to wipe out small land holdings, and bring the lands into the hands of a few of the nobility. He cited but one country where the reverse had been the rule, which was in the south and east of Spain, and pointed out the reason, as he conceived it, that in south and southeastern Spain the ownership of the water went with the land and was inseparable from it, under ancient Moorish rights. It is a fact that where the ownership of water goes with the land, it prevents centering of land ownership into few hands, after that ownership is once divided among many persons, in irrigated regions. But Mr. Marsh overlooked one thing in predicting harm in our country; that is, that it will be many years before we will get such a surplus of poor as to bring about the result he feared. In California, the effect of irrigation has not been to center the land in the hands of a few. On the contrary, the tendency has been just the other way. When irrigation was introduced, it became possible for small landholders to live. In Fresno county there are many people making a living for a family, each on 20 acres of irrigated land, and the country is divided into 20 and 40 acre tracts and owned in that way. In San Bernardino the same state of things prevails. Before irrigation, these lands were owned in large tracts, and it was not an uncommon thing for one owner to have 10,000 to 20,000 acres of land. So that the rule in California, which is the effect of irrigation, is to divide the land holdings into small tracts, and in this respect, also, irrigation is a blessing to the country. It enables large owners to cut up their lands and sell out to the many. Land values have advanced from $1.25 in this great valley to $50, $150 and even $250 per acre, simply by attaching to the land the right to take or use water, paying in addition an annual rental; in the southern portion of the State they have advanced from $5 and $10 to $500 and even $1,000 an acre, where the land has the right to water; and many calculations have been made and examples cited by intelligent and prominent people, to show that good orange land or good raisin-grape land with sufficient water supply is well worth $1,000 an acre. Water rights run up proportionately in value. A little stream flowing an inch of water—an amount that will flow through an inch square opening under four inches of pressure—in the southern part of the State, is held at values ranging from $500 to $5,000. Such a little stream has changed hands at $5,000, and not at boom prices either. In the interior prices are much less, being from about a quarter to a tenth of those in the far southern part of the State.

Fully one-fourth of the United States requires irrigation. When I say that, I mean that fully one-fourth the tillable area of our country requires irrigation, in order to support such a population as, for instance, Indiana has. The irrigated regions of Italy support populations of from 250 to 300 people to the square mile; of south France, from 150 to 250 people to the square mile; of southeast Spain, from 200 to 300. When we have 50 to 100 to the square mile in an agricultural region, we think we have a great population.

The great interior valley of California will not support, without irrigation, an average of more than 15 to 20 people per square mile. Irrigate it, and it will support as many as any other portion of the country—reasonably it will support 200 to the square mile. I have no doubt that the population will run up to ten or twelve millions in that one valley, and there are regions over this country from the Mississippi to the Pacific, millions of acres, that can be made to support a teeming population by the artificial application of water. And why has it not been done before? Simply for the reason that there is a lack of knowledge of what can be done and a lack of organization and capital to carry out the enterprises.

The government has recently placed at the disposal of the United States Geological Survey an appropriation for the investigation of this subject, to ascertain how irrigation can be secured, the cost of irrigation works, and point out the means for irrigation, in the arid regions. It is one of the wisest things Congress ever did; wise in the time and in the subject. The time will soon come when the question would have been forced upon the country, and the wisdom of preparing for that time cannot be too highly commended.

[REPORTS FROM THE CONSULS OF THE UNITED STATES.]

COOKERY FOR WORKINGMEN'S WIVES.

Report by Consul UNDERWOOD, of Glasgow.

I HAVE the honor to state that I was lately invited to be present at a demonstration of a school for women in cooking and other branches of domestic economy. I should not, perhaps, be justified in making this report if the instruction followed ordinary lines. The novelty consists partly in cheapness, and having seen a good, palatable, and nutritious meal for six persons prepared at a cost of 1s. (24 cents), and having observed the ameliorating influences flowing out from the school, I have thought some account of it might be of use in certain crowded districts of the United States, where the advice and assistance of the benevolent is needed.

The school was established three years ago in Govan, a large shipbuilding town adjoining Glasgow, by Mrs. John Elder, widow of the well known shipbuilder, and all the expenses thus far have been paid by her. It is held in Broomloan Hall, belonging to the established Presbyterian church, under the charge of Rev. Dr. Macleod, who, with Mrs. Macleod, has taken an active part in promoting the work.

The teacher, Miss Martha H. Gordon, is a sensible and practical woman, and has shown great tact in gaining the good will and sympathy of those among whom she has labored. This confidence appears to be an indispensable prerequisite; the distrustful attitude of those needing help often frustrates any attempt to benefit them. The school, though primarily aiming at humble things, seems likely to have the broader effect of raising the plane of life and morals.

The pupils are in two classes, (1) mothers and unmarried women over twenty, and (2) girls of twenty and under. Girls are not generally received until they have left school. Each class meets twice a week for lessons in cooking and once a week for darning and mending. Instruction is also given in starching and ironing.

In the leisure hours of every day Miss Gordon goes as a friendly adviser, to houses in the district, wherever she is asked—sometimes to pupils' houses, sometimes to others—giving practical instructions upon all household matters. The mothers' class this last season numbered over two hundred, the younger class about one hundred and thirty. The attendance was naturally more regular in the latter. The numbers in both classes have been far too large for one teacher. From seventy-five to one hundred should be the maximum number, and for the next season additional teachers will be employed.

The two classes represent about two hundred families, all of which, and a great many more, have been often visited by the teacher. The pupils are the wives and daughters of workmen in ship yards and machine shops and of common laborers. The teacher thinks there is a visible improvement in the condition of at least thirty families, with hopeful signs in more. The gain is in personal neatness, in manners, speech, and general tone. The houses are more tidy and the children better clothed, and there are other cheerful signs, such as flower pots in the windows. The teacher thinks the younger pupils will be lifted permanently, and not relapse when they become mothers of families. At present the chief obstacle in the way of improvement is the want of education. The girls read fairly, but write with difficulty.

The heads of these families earn from 15s. to 25s. per week ($3.75 to $6.25). For a house of one room (meaning one room in an apartment house) the rent is from £6 to £7 per annum ($29.16 to $34.02); for a house of two rooms, from £7 to £9 ($34.02 to $43.74). The taxes, water, and gas amount to about one-fifth as much as the rent in addition. A very little arithmetic is necessary to show how small a sum is left for clothing and food. From these statements the importance of a system of instruction by which food can be prepared at low cost will be evident.

In many respects the instruction has been general, that is as to the ways and means by which all successful cooking is best carried on, but the materials have been chosen with rigid economy, so as to produce satisfactory results with the least money. It is easy enough to cook good dinners when there is an unlimited larder.

Mrs. Elder offered a series of prizes in money and in books, from £2 ($9.72) downward, and on the day of the demonstration there was a long show of bowls filled with hotch-potch (a broth with an abundance of minced vegetables), of oat cake, and of scones (thin wheaten cakes made light with baking powder). There were shown, also, specimens of mending clothes, of darning stockings, of ironing shirts, etc. The teacher, assisted by two pupils, stood upon a platform before the cooking range, and went through all the operations required to prepare and cook a meal. Every process and mode of manipulation was explained step by step. This occupied nearly two hours, and there were produced several excellent dishes; a fish soup, a kidney and liver soup, and a meat pie were the most successful. The fish soup was made of a large cod's head, with the addition of rice, onions, and potatoes. The kettle contained over six quarts, and the cost was a little more than sixpence. The meat pie is called "sea pie," because it is in general use among sailors. The peculiar excellence of Miss Gordon's method is in making the meat tender and the crust light and not greasy. The flavor was excellent. The exact cost of each dish was given.

The competition was not for the production of any one dish. Each competitor furnished in writing a plan for a series of fourteen dinners for a family of six, no dinner to exceed 1s. (24 cents) in cost, the price and quantity of each ingredient to be stated. One dinner was produced by each, for which the soup was broth. Each competitor also baked scones and oat cakes.

After the examination of the specimens of cookery, mending, etc., the company adjourned to the large hall. The chair was taken by Dr. McLean, surgeon-general of the British army, who made a speech full of good sense and of practical knowledge, and with a clearness and beauty of phrase that left nothing to be desired. The hall was completely filled by the pupils and their families and friends. The prizes were given to the successful competitors, and a large number of books were bestowed upon other meritorious pupils. The scene was really affecting, mainly on account of the condition of the people interested. The bestowal of honors at a university was a commonplace affair in comparison.

I have been furnished with a set of these simple *menus*, fourteen in number, but I do not send them, as a small book is in press, nearly ready, giving full details, a copy of which will be forwarded.*

The time will soon come, if it has not come already, when efforts of the kind here described will be needed in the more populous districts of the United States, and without depreciating the benevolent institutions which aim to diffuse intellectual and moral influences among the working people, I submit that showing them how to live comfortably upon their small wages and inducing them to cultivate habits of order, neatness, and self-respect is not less important.

F. H. UNDERWOOD, Consul.

United States Consulate,
Glasgow, September 6, 1888.

[Inclosure in Consul Underwood's report.]

COOKERY FOR WORKINGMEN'S WIVES.

By MARTHA H. GORDON, as taught in Mrs. JOHN ELDER'S domestic cookery classes, at Govan, near Glasgow, Scotland.

PREFACE.

One of the principal objects of the instruction in domestic economy provided and organized in Govan some years ago by Mrs. John Elder is to teach plain and economical cookery to women in classes, and especially at their homes.

Since this movement was begun, domestic economy has been more largely taken up by school boards in classes from the fifth standard upward. Obviously, however, great need still exists, and must continue to exist—many of the children leaving the schools before they reach the fifth standard—for instruction of the kind and given in the mode contemplated by Mrs. Elder. The recipes in this little cookery book are among those which I have been in the habit of teaching and illustrating, in fulfillment of the duties assigned to me by Mrs. Elder.

They are here printed with the hope that they may be useful, not only to those attending the classes here and in the homes of Govan, but to the wives and daughters of artisans elsewhere. Some recipes for more advanced cookery have been added, together with directions in regard to washing, sanitary hints, etc. But it will be observed that the great aim kept in view is to help workingmen's wives to provide thoroughly good and nutritious food for their families at the smallest possible cost.

Some of the ingredients are, perhaps, not commonly used, but the use of them does not involve much trouble, and they will be found to make nutritious and substantial meals.

(1) Let me say, do not despise the importance of proper food to the human body. In order to nourish properly every part of the human body, food should be carefully prepared and often varied. It is one of the duties of women, and a very important one, to attend to this. The mother of a family should grudge no trouble to gain skill and knowledge as to the best method of providing nourishing and palatable food for her husband and children. My experience has shown me that there are very many good, nutritious dishes to be made at exceedingly small cost. Unhappily, there are comparatively few who will take enough thought or trouble to prepare them. How many of our homes would be healthier, brighter, and happier if our women could only be brought to see how much depends on them, and bestir themselves in the matter.

(2) Do not despise the use of what are called scraps of meat. Scraps of meat, which can be got cheap from the butcher, will, with care and attention, make good pies and stews, and are as nutritious as more expensive cuts. A workingman's wife who studies economy and tries by careful cooking to get all the nourishment possible out of food will be able to feed her family on a tenth of what one who is careless and ignorant requires.

(3) The great art in cooking is to keep in all the nutrition, salts, etc., of our foods, and to prevent them from being wasted in vapor up the chimney or through the house. All foods, whether heat giving, flesh forming, or stimulant, should therefore be cooked so as to keep in their several juices and flavors. All foods over or under done are wasteful.

(4) Of the various modes of cooking, I think one of the most economical, if attended to, is stewing. A clean pot with a close lid is required for stewing. After the stew is in the pot and warm do not remove the lid till it is ready, but give the pot a shake once or twice to keep it from sticking, and when done you will have a dish with all the nourishment and flavor in it.

(5) To boil meat for soup put it in cold water to dissolve all the juices. To boil meat so as to keep in the juices put it in boiling water and boil fast for ten minutes to form a crust to keep in the juices, then simmer.

(6) All bones for soup should be boiled for some hours, when the fire is not otherwise in use, so as to take all the goodness out of them, and this has not been done until they are perfectly light. The common practice of taking only two hours to boil a bone for soup is both careless and extravagant. If you wish to make a penny go as far as possible by preventing the loss from any article of food you cook of a single element of flavor or nutritiveness, which is the object of perfect and economical cookery, remember to boil long and slowly, keeping the lid of your pot on as close as possible. By this means a pot of soup costing only a few pennies

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* Published herewith.

will be more savory and enjoyable than one costing many shillings and carelessly made.

(7) Some sweet herbs, such as thyme, marjoram, mint, etc. (which can be grown at your windows), or a little celery seeds and two or three cloves tied in a bit of muslin, are a great improvement to many soups and stews.

(8) It is much better, when you can, to grate your vegetables; both the flavor and color are better than when boiled and put through a sieve.

(9) In selecting vegetables see that they are perfectly fresh. After washing and trimming them, leave them in cold water and salt for an hour, so as to get rid of any slugs and make them crisp if drooping. To cook green vegetables, such as cabbage, greens, etc., have plenty of water with salt and a little soda in it, and when quite boiling put in the vegetables and boil quickly. Do not close lid of pot, and remove all scum as it rises. Without attention to these directions the vegetables will not be a good color. All water that green vegetables have boiled in should be taken to the ash pit, as if put down the sink the smell would be very unpleasant in the house. With roots, such as turnips, carrots, etc., the lid may be kept on the pot. Turnips should be peeled rather thickly, then cut in four, or in slices, and boiled till tender. Carrots are only scraped, not peeled, then cut lengthways in four, and boiled till tender. If onions be boiled whole, care must be taken not to cut their tops too short, as they will fall to pieces. Never leave vegetables in the water after they are cooked enough.

(10) The following recipes are specially intended for the ordinary kitchen utensils and open fires. Some of them may appear to be repetitions, but this is not the case, as the same ingredients, when cooked in a different way, will produce a different result. Should any of the recipes seem long, it must be remembered that they, in some cases, give complete dinners, and so contain several recipes in one.

(11) The quantities specified are, as a rule, given in proportions suitable for a family from four to six in number, and the prices given are averages.

M. H. GORDON.

PLAIN HOUSEHOLD COOKERY.

Porridge.—To make really good porridge let the water come to the boiling point before the meal is put in. Pour the meal in from the left hand in a continuous stream, stirring all the time till it comes to the boil. In this consists the chief art of porridge making, and on its being well done depends the smoothness. Allow it to boil for ten minutes, then add the salt. Salt has a tendency to harden, and would prevent the meal from swelling. Boil for ten minutes after the salt has been added. Dish and take with milk.

The quantity and consistency of the porridge must be regulated by the cook.

Wheat Meal Porridge.—Have 1 quart of water at the boiling point; take three good handfuls, or about 2½ teacupfuls, of wheat meal; pour the meal regularly from the left hand, stirring all the time. There must be no lumps in it. Boil for ten minutes, add salt to taste, and boil for ten minutes more. Serve with milk, treacle, or stewed fruit.

Porridge (for indigestion).—One pound barley meal, 1 pound oatmeal, 2 pounds wheat meal, 1 pound Indian meal; mix well together, proceed in the same way as with wheat meal porridge, but boil for half an hour instead of twenty minutes.

To Make a Cup of Good Tea.—One teaspoonful of tea to every half pint of water; have the teapot well rinsed in hot water; put in the tea, take a piece of paper and close the spout, set the teapot near the fire, but not so near as to burn, for ten minutes; have the water boiling and add; do not let it stand longer than six minutes after adding the water. Remove the paper from the spout and you will find you have a cup of tea with all the aroma in it. Sugar and cream to taste.

Be sure not to allow the water to boil too long. It is best taken when it first comes through the boil.

Coffee.—One teaspoonful of coffee to each breakfast cup. An earthenware pot is best; have it very clean and hot. Put in the coffee, close the spout to keep in all the aroma, let it stand at the fire, not too near, for ten minutes; when the water boils, pour it into the pot and cover close. Do not boil your coffee, but see that your lid is very close, so that all the fine flavor is preserved.

How to Boil Eggs.—Put one pint of water in a small pan; let it boil; put in the egg; if small, three minutes will set it; if large, four minutes. When boiling several eggs see that they are as nearly as possible the same size. Ten minutes is required to boil an egg hard.

Poached Eggs.—Put 1 pint of water in a small pan, with half a teaspoonful of salt, and a tablespoonful of vinegar; let it boil; break the egg carefully into the pan, and simmer for four minutes. Take it out and carefully serve on toast.

French Toast.—Break and beat an egg well, add a pinch of salt and 1 gill of milk, dip some neat slices of bread in on both sides. Have your frying pan with some hot dripping ready, then fry the bread a light brown.

This is good with stewed rhubarb laid on the top.

A Nice Breakfast.—One fourth pound of old cheese, a teacupful of milk, two eggs, a pinch of salt, a pinch of pepper, a small bit of butter. Cut the cheese very thin, put it into a frying pan with half of the milk, butter, pepper, and salt. Stir until the cheese is melted, then add the eggs, well beaten, with the rest of the milk. Cook for one minute and spread on hot toast.

Eggs Stewed with Cheese.—One egg for each person. Let them set in a frying pan, remove them to a plate. Cut some cheese very thin; put it on the top of the eggs, with salt and pepper to taste. Set before the fire or in the oven to swell, and serve hot.

Ham and Eggs.—Put your sliced ham on in a cold frying pan, turn it two or three times, taking care not to let it burn.

When sufficiently done lay the ham on a nice hot plate. Break the eggs into a cup, taking care not to break the yolks; slip one at a time into the frying pan and baste with the ham fat. Keep the eggs as round as possible, lift with a slice, and lay on the ham.

Omelet (plain).—In making an omelet care should be taken to have the pan quite hot and perfectly dry. Put into the frying pan 1 ounce of lard, beat very gently (the lard must not get brown). The eggs are to be very lightly beaten, only long enough to mix them and no more. Break 4 eggs into a basin, half a teaspoonful of salt, and a quarter of a teaspoonful of pepper; mix, pour into a hot pan, and keep mixing quickly, till they are delicately set. Turn in the edges, let it rest a moment to set, turn it over on a dish, and serve.

Omelet.—Two eggs, 1 teacupful of milk, 1 tablespoonful of corn flour, 1 tablespoonful sugar, pinch of salt, teaspoonful essence vanilla. Put the yolks of the eggs in a basin and stir them till they are light. Add the milk to them, then add, gradually, to the corn flour and other ingredients in another basin; stir till very smooth; beat the white of the eggs to a snow and add them very gently with the essence vanilla to the rest of the mixture. Have a hot frying pan, put in a little lard and melt, pour in all the mixture, and hold it over a gentle fire for a quarter of an hour, till set and well risen; brown the sap before the fire, or bake for a quarter of an hour in the oven.

Colored Eggs for Easter.—Eggs can be dyed a pretty color with the juice of a beet root, or the peel of onions boiled in the water; or, if you have a patch of fancy print, bind it around the egg and boil it, and it will leave the impression. Wash the eggs clean before boiling. Easter eggs should be boiled for ten minutes.

Kedgeree.—One pound fish, one-fourth pound rice, 3 eggs, 1 ounce butter. Wash rice well, put on in boiling water, and boil till soft; boil the fish and take away all bones and skin and separate into flakes. Boil three eggs for ten minutes, then throw into cold water to prevent their turning black, then peel and cut fine. Drain all the water from the rice, put it on the fire to dry, add the butter, salt, pepper, fish, and eggs (saving one of the yolks), let it all warm, and then dish and grate the yolk of the egg over it.

(To be continued.)

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